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Revision of *Hermannia* subgenus *Hermannia* in southern Africa

I. C. VERDOORN*

ABSTRACT

Observations on the genus as a whole are made and the subgenus *Hermannia* is defined. Species in southern Africa which fall in this subgenus are revised in detail. A key is provided to these 93 species and several line drawings illustrate some of the diagnostic features used in the key.

RÉSUMÉ

REVISION DU HERMANNIA SOUS-GENRE HERMANNIA EN AFRIQUE AUSTRALE

A des observations sur le genre dans son ensemble, cet article joint une définition du sous-genre *Hermannia*. Les espèces d'Afrique australe qui appartiennent à ce sous-genre sont révisées en détail. Il y en a 93, pour lesquelles on fournit une clé d'identification et plusieurs dessins au trait qui illustrent certains des caractères diagnostiques utilisés dans la clé.

INTRODUCTION

This revision is a contribution towards a treatment of the genus *Hermannia* for the Flora of Southern Africa. The format followed is that formerly used for the F.S.A., which differs in several respects from that generally employed in *Bothalia*.

In the course of the work thousands of herbarium specimens, both in the National Herbarium, Pretoria, and on loan from overseas herbaria, such as Leningrad, Vienna, Stockholm and Zürich, were studied.

The genus, like so many others, presents great difficulties to the taxonomist in his attempt to define satisfactorily the sub-genera and some of the species. Intermediates, aberrants and putative hybrids abound. Before *Mahernia* L. was put into synonymy under *Hermannia* L., Benth & Hooker in their *Genera Plantarum* (1862), separated these genera on the shape of the filaments. Those of *Hermannia* were described as "oblong or dilated at the apex" and of *Mahernia* as "dilated in the middle", the latter termed "cruciform" by subsequent authors. In 1895 K. Schumann (Natürl. PflFam. 3, 6: 80) placed *Mahernia* L. as section *Mahernia* in the genus *Hermannia* remarking that, since the main distinguishing feature, namely cruci-

form filaments, did not hold among species subsequently put in *Mahernia*, it could not be upheld as a genus. Later, in Engl., Monogr. Afr. Pfl. 5, 49 (1900), K. Schumann raised the section to subgeneric rank as subgenus *Mahernia* (L.) K. Schum. This has been supported in the present study, for not only has "cruciform" been variously interpreted but it occurs in groups that are not otherwise related.

Just as it has been found impracticable to separate these two genera, so the genus *Hermannia*, in the broad sense, is not readily grouped into subgenera. Exploring several features which might be diagnostic, such as inflated calyces, horned capsules, deeply divided leaves and different forms of pubescence, it was found that these characters can only be used to separate species which occur in a number of small subdivisions.

Forced back to a consideration of the shape of the filaments, it was found that the species reviewed here all agreed in having abovate, obtrullate, linear or narrowly oblong filaments in which the anther bases overlap the expanded portion of the filaments (Fig. 1.1-1.4). On these grounds the genus could be separated into two subgenera as keyed out below.

Key to subgenera

- Filaments obovate, obtrullate, linear or narrowly oblong, with the anther base overlapping the expanded portion of the filaments.....subgenus **Hermannia**
- Filaments abruptly dilated in the upper half or at the apex (more or less cruciform), rarely linear or narrowly obovate-oblong but then the anther base not overlapping the expanded portion of the filaments (Fig. 1.5-1.9).....subgenus **Mahernia**

HERMANNIA SUBGEN. HERMANNIA

Hermannia L. subgen. *Hermannia*

Subgen. *Euhermannia* Harv. in F.C. 1: 180 (1860); K. Schum. in Engl., Monogr. Afr. Pfl. 5, 49 (1900).

Subgen. *Acicarpus* Harv. in l.c. (1860); K. Schum., l.c. (1900).

Type species: *H. hyssopifolia* L.

Herbs, undershrubs or rarely small shrubs, procumbent or erect, generally stellate-pubescent often with

glandular or simple hairs intermixed. *Leaves* alternate, entire, lobed or incised; stipules sometimes foliaceous. *Inflorescence* of simple or compound 1 to several-flowered cymes, axillary or leaf-opposed. *Calyx* 5-lobed, tube campanulate to globose. *Petals* 5, obovate to oblong, often narrowed into a claw at the base, slightly to very strongly spirally twisted. *Stamens* 5, filaments expanded, obovate, obtrullate, linear or narrowly oblong, the expanded portion overlapped by the anther base, anthers acuminate, ciliate. *Ovary* 5-loculed, styles 5, cohering. *Capsule* loculicidally dehiscent, 5-loculed; locules with rounded apices or with short to long horn-like appendages.

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FIG. 1.—Stamen types in *Hermannia*. 1–4, filaments as in *Hermannia* subgen. *Hermannia*, all with the anther base overlapping the dilated portion: 1, filament obovate-cuneate, *H. althaeifolia* (De Winter & Verdoorn 9063); 2, filament more or less linear-oblong, *H. filifolia* (Taylor 6494); 3, filament narrowly oblong-obovate to obtrullate, *H. angularis* (De Winter & Verdoorn 9097); 4, filament narrowly obovate, dilated at the apex, *H. cristata* Compton 30024). 5–9, filaments as in *Hermannia* subgen. *Mahernia*, variously shaped but the anther base not overlapping the dilated portion: 5, filament abruptly dilated in the upper half (cruciform), *H. aurocoma* (Acocks 12314); 6, filament abruptly dilated at the apex (subcruciform), *H. argillicola* (Dinter 8041); 7, filament broadly dilated at the apex, *H. grossularifolia* (Marloth 5300); 8, filament more or less linear, *H. oligospermum*, (Esterhuysen 15496); 9, filament obovate-cuneate *H. stricta* (Rösch & Le Roux 549).

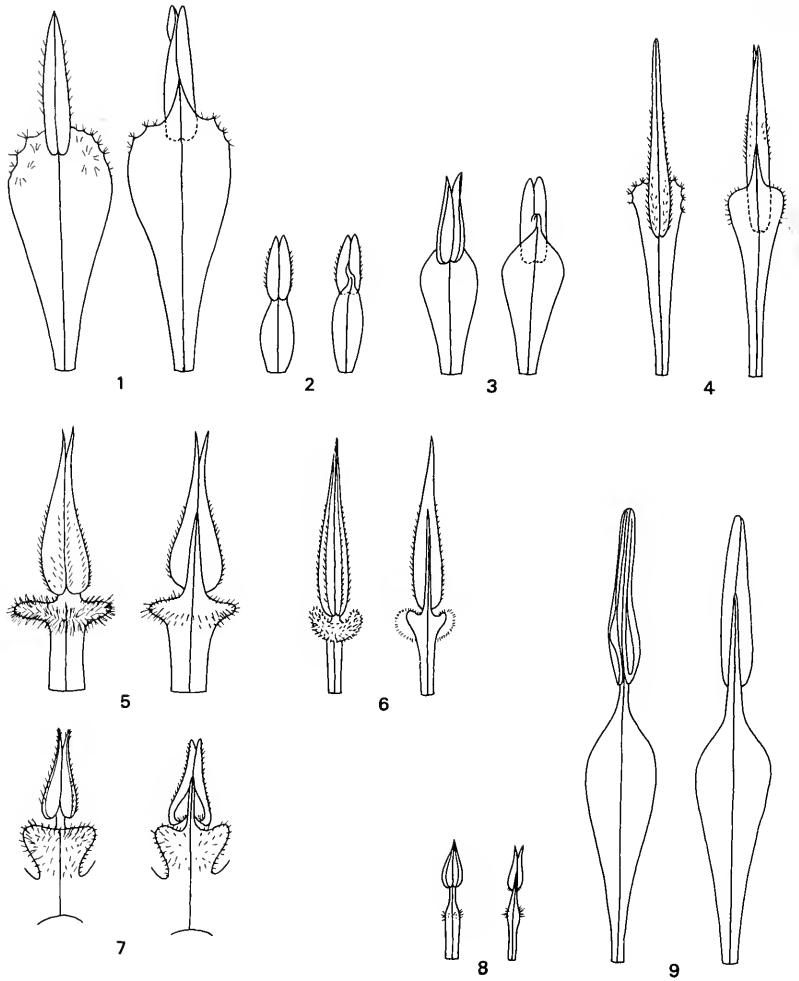
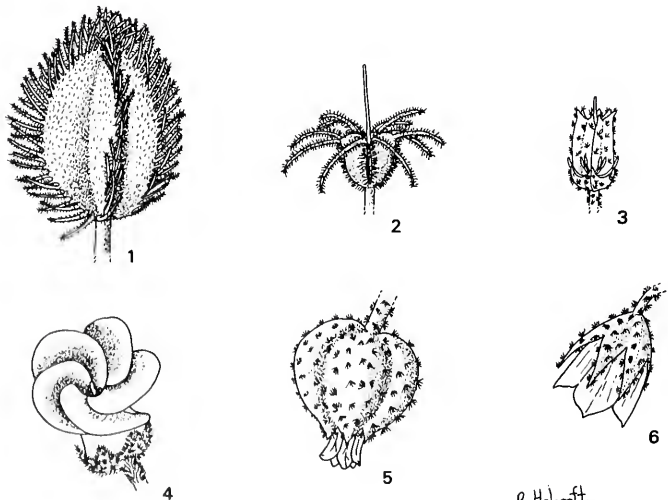


FIG. 2.—Some diagnostic characters relating to capsules and flowers in the subgen. *Hermannia*. 1, capsule 5-angled, fringed on the angles, *H. cristata* (I. Thornecroft 3937); 2, capsule with a pair of horns (developing with age) at the apex of each angle, *H. spinosa* (Coetzee & Werger 1739); 3, capsule not fringed on the angles and not horned at the apex, *H. prismatocarpa* (De Winter & Verdoorn 9067); 4, flower with strongly twisted petals (dolls roses) and calyx not inflated, *H. prismatocarpa* (after Flower. Pl. Afr. t. 1625); 5, calyx inflated, *H. comosa* (De Winter 9107); 6, flowers with petals not strongly twisted, more or less bell-shaped, *H. spinosa* (Schlieben 8841).



KEY TO THE SPECIES

- 1a Capsules fringed on angles with crowded tentacle-like or filiform processes (Fig. 2.1):
- 2a Low suffrutex, several stems from a stout rootstock, leaves narrowly elliptic-oblong to lanceolate; fringe of capsule of fairly stout 7 mm long processes; Eastern Escarpment and Soutpansberg.....1. *H. cristata*
- 2b Suffrutex up to 2 m tall, leaves large, suborbicular; fringe of capsule of long, filiform processes; S.W.A.2. *H. merxmuelleri*
- 1b Capsules not fringed as above:
- 3a Stems erect, many from a woody rootstock, short, under 30 cm long, more or less leafless in lower half with a few large leaves and yellow flowers borne in upper half.....3. *H. sandersonii*
- 3b Habit not as above:
- 4a Inflorescence of simple 1-flowered cymes solitary in axils of leaves on branches of indeterminate growth, sometimes appearing racemose when upper leaves are much reduced; petals not strongly contorted, open flowers bell-shaped (Fig. 2.6):
- 5a Petals shorter than calyx, rarely about as long but then shorter than stamens:
- 6a Plants with at least outer branches long and trailing; leaves more or less secund:
- 7a Leaf-margins conspicuously and densely fringed with hoary-pilose hairs.....4. *H. seineri*
- 7b Leaf-margins not as above:
- 8a Leaves finely and densely stellate-tomentose at least when young, hairs under 0,5 mm long.....5. *H. tomentosa*
- 8b Leaves densely or sparsely coarsely stellate, hairs comparatively long.....6. *H. eenii*
- 6b Plants bushy, erect or suberect:
- 9a Branchlets predominantly glandular-pubescent at least in upper half (rarely in *H. boraginiflora*, e.g. *Gilliland* 746, not conspicuous or absent):
- 10a Leaves sparsely to fairly densely stellate-pubescent:
- 11a Capsule densely stellate-pubescent all over; in addition to glandular hairs, branchlets mainly appressed stellate-pubescent.....7. *H. boraginiflora*
- 11b Capsule glandular-pubescent between the sutures, glabrescent:
- 12a Branchlets with many patent, gland-tipped hairs intermixed with long, pointed, patent hairs.....8. *H. glanduligera*
- 12b Branchlets densely pubescent with short (under 2,5 mm), glandular hairs not obviously gland-tipped.....9. *H. viscosa*
- 10b Leaves finely stellate-tomentose on both surfaces:
- 13a Leaves small, mostly under 1,5 cm long; glandular hairs conspicuous on most parts of plant; S.W.A.....10. *H. glandulosissima*
- 13b Leaves up to 4,5 cm long; glandular hairs conspicuous only in upper portion of branchlets; Transvaal.....11. *H. grisea*
- 9b Branchlets not predominantly glandular-pubescent:
- 14a Low plant with a few slender branches, calyx-lobes long, subulate; capsule with long, slender horns.....12. *H. solaniflora*
- 14b Suffrutices, capsules not or shortly horned:
- 15a Leaves stellate-tomentose:
- 16a Leaves very small, mostly under 4 mm long, often recurved, lateral branches subspreading, slender, rigid.....13. *H. minimifolia*
- 16b Leaves mostly over 5 mm long and up to 22 mm long; lateral branchlets not as above:
- 17a Bush, branched at base, branches long and slender, forming a rounded bush about 1 m in diameter; leaves drying a light colour; anthers obvious, usually drying a dark violet; occurs in south-western areas of S.W.A.....14. *H. engleri*
- 17b Suffrutex, stems erect, branchlets arcuate-ascending or suberect; leaves drying a darker colour; anthers sometimes dark violet; occurs in the northern areas of S.W.A. around the Etosha Pan.....15. *H. guerkeana*
- 15b Leaves stellate-pubescent but not tomentose; found only along east coast of Zululand and Mozambique.....16. *H. micropetala*
- 5b Petals as long as or longer than calyx:
- 18a Gland-tipped hairs obvious, especially on branchlets and petioles:
- 19a Flowers in long, distinct pseudoracemes; petals usually over 1,5 cm long and with a dark blotch near base showing even on dried specimens; capsule blunt.....17. *H. amabilis*
- 19b Flowers axillary or in short, not very distinct pseudoracemes; petals usually under 1 cm long, without a dark spot near base; capsule apiculate or shortly horned at apex of sutures.....18. *H. modesta*
- 18b Gland-tipped hairs not obvious on branchlets and petioles:
- 20a Annuals, sometimes biennial or triennial:
- 21a Weak annual with small flowers usually under 5 mm long; leaves broadly to narrowly ovate-acuminate.....19. *H. tigrensis*
- 21b Bi- or triennial; flowers 5 mm or longer; leaves variable.....18. *H. modesta*
- 20b Suffrutices, perennial, flowers usually over 5 mm long:
- 22a Leaves very narrow, under 2 mm wide, appearing ericoid, clustered.....20. *H. linearifolia*
- 22b Leaves not as above:
- 23a Capsule shortly horned; leaves and branches stellate-tomentose, not laxly stellate-pubescent:
- 24a Flowers in pseudoracemes on long, slender branches.....21. *H. helianthemum*
- 24b Flowers axillary:
- 25a Calyx 5-ribbed, lobed to less than halfway; pubescence same on calyx and leaves.....22. *H. damarana*
- 25b Calyx not distinctly 5-ribbed, lobed to beyond middle; pubescence on calyx longer and coarser than on leaves.....23. *H. gariepina*

- 23b Capsule with long, spreading, pilose horns; leaves and branchlets stellate-pubescent or stellate-tomentose (Fig. 2.2):
- 26a Leaves and branchlets stellate-tomentose, at least when young:
- 27a A small, many-stemmed leafy bush; confined to edge of Namib.24. *H. complicata*
- 27b Suffrutex, divaricately branched, branchlets becoming leafless and indurated:
- 28a Flowers many, secund, in pseudoracemes; western Cape to S.W.A.25. *H. trifurca*
- 28b Flowers in axils of upper leaves; Kalahari and S.W.A.26. *H. affinis*
- 26b Leaves and branchlets stellate-pubescent, not tomentose, or glabrous and minutely papillose:
- 29a Virgate, erect suffrutex, leaves and branches appearing glabrous but glutinous.27. *H. fruticulosa*
- 29b Rounded bush with wiry stems; leaves and branchlets stellate-pubescent, glabrescent; peduncles persisting, spreading, indurated, giving spiny appearance to bush.28. *H. spinosa*
- 4b Inflorescence of simple or compound, 1-several-flowered cymes on same plant, arranged in axils of upper leaves and at apices of branchlets forming leafy or leafless, racemose or panicle cymes, if all cymes 1-flowered, then in sparse terminal racemose cymes; petals strongly contorted ("doll's roses"; Fig. 2.4), open flowers not bell-shaped:
- 30a Leaves entire or shallowly crenate or toothed on the margins, if somewhat deeply lobed then not halfway to midrib:
- 31a Plants with long, decumbent branches, inflorescence and secund branchlets ascending, all terminating in a leafless inflorescence:
- 32a Leaves long and narrow 1-3 mm broad in middle, appearing linear but tapering slightly towards base into an obscure petiole.29. *H. linifolia*
- 32b Leaves distinctly petioled, blade oblong to ovate, 5-30 mm broad in middle:
- 33a Flowers 1 cm long or longer, clustered at ends of branchlets on short pedicels, shorter than flowers:
- 34a Pubescence sparse, stellate hairs short and appressed (see also under 30b).89. *H. procumbens* subsp. *procumbens*
- 34b Pubescence conspicuous, hairs in part long, grey and matted.30. *H. decumbens*
- 33b Flowers under 1 cm long, not markedly clustered on short pedicels at ends of branchlets:
- 35a Branches fairly densely stellate-pubescent, often with long stiff hairs intermingled; capsule elongating to over 1 cm long (Fig. 2.3).31. *H. prismatocarpa*
- 35b Branches appear glabrous, sometimes sparsely and inconspicuously stellate-pubescent, hairs few, short or some slightly longer; capsule short, broad, usually under 1 cm long.32. *H. scordifolia*
- 31b Plants not as above but erect suffrutices, sometimes bushy with ascending branches, or low, woody and sprawling; inflorescences various:
- 36a Leaves and stipules imbricate, leaves usually longer than internodes, about 12 mm long or less (see also *H. stipulacea* under 36b):
- 37a Calyx and leaves densely and coarsely pubescent with stellate and tufted golden brown hairs (see also under 36b).75. *H. decipiens*
- 37b Calyx not densely and coarsely pubescent as above:
- 38a Leaves finely tomentose or tomentellose; calyx lobed to about one third of its length:
- 39a Leaves distinctly petioled; mature flowers 10 mm long or more; calyx inflated.33. *H. ternifolia*
- 39b Leaves sessile or subsessile; open flowers less than 10 mm long; calyx subinflated.34. *H. trifoliata*
- 38b Leaves rough with minute fringed scales or hirsute; calyx lobed halfway or beyond:
- 40a Leaves broadest at apex, rough with minute fringed scales.35. *H. concinnifolia*
- 40b Leaves narrowly oblong, sparsely hirsute with long, bulbous-based hairs.36. *H. muirii*
- 36b Leaves and stipules not obviously imbricate as above:
- 41a Leaves generally broadest in lower half or oblong-elliptic to broadly oblong:
- 42a Pubescence mainly rough, especially on branchlets, mostly of dense or sparse, stiffly stellate or bulbous-based hairs:
- 43a Calyx inflated, narrow at mouth, sinuses narrow (Fig. 2.5):
- 44a Calyx narrowly urceolate, lobes deltoid; leaves coarsely and densely pubescent with tufted or stellate hairs from a scaly base (see also under 41b).54. *H. salviifolia*
- 44b Calyx globose; leaves mostly basal (also under 42b).46. *H. comosa*
- 43b Calyx not inflated or if subinflated then campanulate to salver-shaped:
- 45a Leaves mainly basal or in lower half of plant, sometimes some leaves deeply lobed or pinnatisect; flowers in long racemose or panicle cymes comprising the upper half to two-thirds of plant (see also under 30b):
- 46a Flowers usually small, up to about 6 mm long on dried specimens; leaves narrowly to broadly oblong or ovate-oblong, coarsely and evenly lobed, 15-20 cm long.91. *H. macra*
- 46b Flowers over 6 mm long and up to 10 mm long:
- 47a Leaves oblong-lanceolate to narrowly lanceolate, dentate to deeply dentate.92. *H. juttae*
- 47b Leaves ovate, coarsely crenate to palmatisect.93. *H. paucifolia*
- 45b Leaves cauline:
- 48a Flowers small, up to 6 mm long on dried specimens, numerous and short-stalked in each inflorescence:
- 49a Calyx subinflated, about 4 mm long on dried specimens.37. *H. floribunda*

- 49b Calyx not subinflated, under 4 mm long on dried specimens:
 50a Leaves distichous, pubescence harsh, mainly of 2 mm long hairs...74. *H. disticha*
 50b Leaves not distichous, mainly under 15 mm long; hairs shorter than 2 mm:
 51a Leaves white-tomentose on lower surface (see also under 41b)...66. *H. alnifolia*
 51b Leaves not white-tomentose on lower surface, pubescence harsh.....38. *H. bryoniifolia*
- 48b Flowers over 6 mm long on dried specimens:
 52a Stipules leaf-like (see also under 42b).....44. *H. althaeifolia*
 52b Stipules not leaf-like:
 53a Leaves thick-textured, densely pubescent, large, up to 4,5 × 3 cm; flowers large, congested in short inflorescences.....39. *H. cordifolia*
 53b Leaves and flowers not as above:
 54a Pubescence mainly hispid, calyx sparsely so to glabrous; leaves mucronate.....40. *H. hispida*
 54b Pubescence mainly of stellate or grouped hairs, calyx subdensely to densely stellate-pubescent:
 55a Leaves strongly crisped as well as crenate on margin; calyx densely stellate with hairs rather long (see also under 41b); Western Province.....41. *H. rugosa*
 55b Leaves shallowly crenate, not strongly crisped as well, stellate pubescence sometimes dense on calyx but hairs not long; Eastern Province.....42. *H. althaeoides*
- 42b Pubescence mainly tomentose, especially on branchlets which are tomentose to smoothly canescent-tomentose or silvery with fringed, pitted scales:
 56a Branches silvery with fringed pitted scales (see also under 30b).....88. *H. pulverata*
 56b Branches canescent-tomentose:
 57a Flowers mostly under 6 mm long on dried specimens:
 58a Leaves tomentose on both surfaces; branchlets always canescent...43. *H. minutiflora*
 58b Leaves white-tomentose on lower surface only; branchlets not canescent (see also under 41b).....66. *H. alnifolia*
- 57b Flowers mostly over 6 mm long on dried specimens:
 59a Stipules leaf-like; calyx hirsute, not narrowed at mouth.....44. *H. althaeifolia*
 59b Stipules not large and leaf-like, calyx not hirsute if hairs long then grouped on stalks:
 60a Calyx inflated, narrowed at mouth:
 61a Flowers secund; leaves shortly petioled.....45. *H. johanssenii*
 61b Flowers not secund; leaves, especially the lower, long-petioled...46. *H. comosa*
 60b Calyx not inflated or subinflated:
 62a Leaves not normally crisped as well as crenate on margins:
 63a Inflorescence of 2-flowered cymes in axils of leaves.....47. *H. incana*
 63b Inflorescence of long, terminal, leafless, compound cymes...42. *H. althaeoides*
 62b Leaves normally crisped as well as crenate on margins:
 64a Leaves broadly ovate to sub-orbicular.....48. *H. vestita*
 64b Leaves narrowly ovate to ovate-oblong:
 65a Calyx subinflated; branches of inflorescence glabrescent, dark and slender.....49. *H. amoena*
 65b Calyx not subinflated; branches of inflorescence not glabrescent....50. *H. disermifolia*
- 41b Leaves broadest at apex or generally broadest in upper half but varying in shape from filiform, narrowly oblong, oblanceolate and broadly oblong-rectangular to subglobose:
 66a Calyx inflated, narrowly urceolate to subglobose, narrowed at mouth:
 67a Leaves softly tomentose on both surfaces:
 68a Tomentum smoothly uniform; plants up to 1 m tall or taller, calyx subglobose.....51. *H. mucronulata*
 68b Tomentum intermixed with long, villous hairs; low plant ± 30 cm high; calyx more or less urceolate.....52. *H. suavis*
 67b Leaves not, or not normally, softly tomentose on both surfaces:
 69a Leaves usually toothed at apex and in upper half, stellate-pubescent with short hairs, glabrescent; calyx subglobose.....53. *H. hyssopifolia*
 69b Leaves entire or occasionally obscurely lobed at truncate apex or in upper third; stellate pubescence rough, usually of thick and tufted hairs from a glandular or tubercled base; calyx urceolate (see also under 41a).....54. *H. salviifolia*
- 66b Calyx not inflated:
 70a Leaves velvety tomentose on both surfaces, entire or very shallowly crenate in upper half:
 71a Stipules not leaf-like:
 72a Flowers small, 3-4, 5 mm long on dried specimens, crowded in compound cymes, terminal on lateral branchlets; leaves fairly broad, often suborbicular, crenate at least at broad apex.....55. *H. holosericea*
 72b Flowers normally 5 mm long or longer; leaves mostly narrow, usually entire and mucronate:
 73a Weak twiggy plants; calyx wide, lobed to middle and beyond, scaly, hairs inconspicuous.....56. *H. lavandulifolia*
 73b Virgate shrubs up to 1 m tall or taller; calyx strongly 5-10-ribbed, lobed in upper half, densely pubescent, hairs conspicuous and foxy-coloured.....57. *H. odorata*

71b Stipules leaf-like:

74a Leaves petioled, petiole not completely hidden by sessile stipules; flowers yellow:

75a Calyx narrowly obconic, strongly 5–10-ribbed; flowers appear narrow-waisted.....58. *H. sulcata*

75b Calyx not narrowly obconic:

76a Calyx broadly campanulate; flowers in terminal, leafy, paniculate cymes.....59. *H. velutina*76b Calyx tubular-campanulate, lobed in upper half; cymes 1–2-flowered in lax, terminal, leafless, racemose inflorescences.....60. *H. gracilis*74b Leaves subsessile, short petiole hidden by broad, sessile stipules; flowers usually garnet-red.....61. *H. diversistipula*

70b Leaves not velvety tomentose on both surfaces, pubescence rough, or smooth and white only on lower surface, if appearing silvery pubescent on both surfaces then calyx and leaves covered by pitted, fringed scales:

77a Leaves on both surfaces, and calyx covered by pitted, fringed scales giving plants a silvery grey appearance:

78a Calyx deeply to narrowly campanulate, lobed in upper third; leaves cuneate; frequent in eastern and western Cape and O.F.S.....62. *H. cuneifolia*

78b Calyx shallowly campanulate to saucer-shaped, lobed almost to middle:

79a Leaves usually deeply divided, if not, then longer than broad, oblong and only slightly narrowed towards base (see also under 30b).....88. *H. pulverata*

79b Leaves never deeply lobed, subglobose to obovate-cuneate:

80a Flowers small, up to 5 mm long on dried specimens; leaves suborbicular, distinctly crenate.....63. *H. desertorum*80b Flowers over 5 mm long on dried specimens; leaves obovate-cuneate, obscurely 3- or more-lobed at broad apex; west coast of Namaqualand and Namib in S.W.A.....64. *H. pfeilii*

77b Leaves and calyx not silvery grey from the covering of fringed pitted scales:

81a Leaves with a white, stellate or cobwebby, appressed tomentum on lower surface only:

82a Calyx densely fawn to brown-tomentose with lepidote stellate pubescence, hairs obvious and straw-coloured.....65. *H. multiflora*

82b Calyx thinly stellate-pubescent, the hairs very short or hispid, not densely brown-tomentose:

83a Flowers small, under 5 mm long on dried specimens, short-stalked, numerous in short, terminal, compound cymes.....66. *H. alnifolia*

83b Flowers usually over 5 mm long; inflorescence not as above:

84a Flowers in long, terminal, leafless, racemose or paniculate cymes:

85a Plants much branched from base, branches arcuate-ascending.....67. *H. muricata*

85b Tall, virgate shrubs:

86a Inflorescence of lax, paniculate cymes; peduncles and pedicels well developed.....68. *H. repetenda*86b Inflorescence of racemose cymes, 1–3-flowered and 1–3 at a node, peduncle usually aborted.....69. *H. rigida*

84b Flowers in short, few-flowered cymes, terminal on short lateral branchlets or leaf-opposed along the leafy branches:

87a Leaves petioled; cymes very slender, many, axillary or leaf-opposed along leafy branches, curved downwards in helicoid fashion.....70. *H. helicoidea*

87b Leaves sessile or subsessile, cymes terminal on short lateral branchlets:

88a Leaves fascicled, strongly crisped, mostly narrowly oblong-cuneate.....71. *H. aspera*88b Leaves single at a node, distichous, broadly obovate-oblong to ovate-oblong, broadly cuneate or rounded at base; only sometimes white-tomentose on lower surface.....74. *H. disticha*

81b Leaves variously pubescent but not with a white, stellate or cobwebby tomentum on lower surface only:

89a Leaves suborbicular or broadly oblong to oblong-obovate, only slightly longer than broad:

90a Flowers crowded in dense heads, densely hispid from long, tubercle-based hairs of calyx.....72. *H. conglomerata*

90b Flowers in lax terminal cymes:

91a Small plant with slender intricate branches and small leaves.....73. *H. micrantha*91b Shrublet 50–90 cm tall with distichous leaves with an average size of 20 × 16 mm (leaves rarely white-tomentose dorsally).....74. *H. disticha*

89b Leaves distinctly longer than broad:

92a Pubescence on calyx dense, golden brown coloured:

93a Bracteoles long, subulate, conspicuous at base of flowers:

94a Leaves small, about 12 mm long, often subimbricate; bracteoles reaching lower third of calyx.....75. *H. decipiens*94b Leaves variable, usually over 15 mm long; bracteoles often reaching to top of calyx.....76. *H. involucreata*

93b Bracteoles not long and subulate:

95a Leaves densely and persistently pubescent on both surfaces.....77. *H. pillansii*95b Leaves laxly to subdensely stellate-pubescent, hairs long from a scaly base.....78. *H. stipulacea*

- 92b Pubescence on calyx not dense and golden brown:
- 96a Branches glabrous or pubescent to scaly-pubescent, at least on new growth:
- 97a Calyx parchment-like, angled at the sinuses, broad-based with broad, ovate lobes; south western Cape (see also under 96b)....85. *H. angularis*
- 97b Calyx not as above:
- 98a Leaves filiform, ericoid, acute, glabrous and clustered; Great and Little Karoo.....79. *H. filifolia*
- 98b Leaves not as above, if some appear filiform (conduplicate) then not completely glabrous or plants restricted to Coastal Fynbos:
- 99a Branches, leaves and calyx glabrous; Western Cape.....80a. *H. denudata* var. *denudata*
- 99b Branches, leaves and calyx not totally glabrous:
- 100a Leaves mostly acute and dentate in upper half; Transvaal.....80b. *H. denudata* var. *erecta*
- 100b Leaves broadest at or near apex which is rounded, mucronate or lobed:
- 101a Calyx half or more than half as long as petals, sinuses V-shaped:
- 102a Leaves glabrescent at least on upper surface, often flat and up to 12 mm broad at apex.....81. *H. flammea*
- 102b Leaves persistently stellate-pubescent on both surfaces, folded, at most 5 mm broad at apex.....82. *H. flammula*
- 101b Calyx usually less than half as long as petals, wide and shallow at maturity, sinuses wide.....83. *H. joubertiana*
- 96b Branches very rough with prominent scattered tubercle-bases or harsh stellate pubescence, rarely glabrescent but rudimentary tubercle-bases can be seen:
- 103a Inflorescence of long, terminal, leafless, racemose or paniculate cymes; petals exerted from calyx-tube by about half....84. *H. scabra*
- 103b Inflorescence terminal on leafy branches and on very short, leafy lateral branchlets; petals shortly exerted from conspicuous calices:
- 104a Calyx glabrous except for small stellate hairs along margins of lobes.....85. *H. angularis*
- 104b Calyx rough with tubercle-bases of stellate or grouped hairs.....86. *H. rudis*
- 30b Leaves all, or at least some, deeply toothed or lobed to about halfway to midrib or pinnately or palmately divided:
- 105a Branchlets or branches of inflorescence canescent with silvery-fringed or stellate scales:
- 106a Calyx large, inflated, subglobose, up to 10 mm diameter; cauline leaves well developed.....87. *H. abrotanoides*
- 106b Calyx small, not inflated, about 5 mm long; leaves mainly basal (see also under 30a)....88. *H. pulverata*
- 105b Branchlets and branches of inflorescence not canescent, usually laxly and roughly stellate-pubescent:
- 107a Stems decumbent with only apical portion ascending; leaves cauline and usually secund, erect from trailing stem (see also under 30a).....89. *H. procumbens* subsp. *myrrhifolia*
- 107b Stems not decumbent; leaves not as above:
- 108a Suffrutex, up to 60 cm tall, much branched above, branches slender; leaves basal and cauline deeply and finely pinnately divided up to 25 mm long; inflorescence of terminal, leafless, racemose cymes.....90. *H. confusa*
- 108b Low plants with many stems from a woody base; leaves mainly basal; inflorescence of long, terminal, leaf-less, paniculate cymes:
- 109a Flowers small, up to 6 mm long on dried specimens; leaves more or less oblong, about 15–20 mm long, broadly and unevenly lobed, sometimes deeply so but not to midrib (see also under 30a).....91. *H. macra*
- 109b Flowers over 6 mm long:
- 110a Leaves oblong-lanceolate to narrowly lanceolate, 20–60 mm long, coarsely crenate or toothed, not palmatisect (see also under 30a).....92. *H. juttae*
- 110b Leaves ovate in outline, 15–30 mm long, usually palmatisect with segments irregularly twice-lobed (see also under 30a).....93. *H. paucifolia*

1. *Hermannia cristata* H. Bol. in J. Linn. Soc., Bot. 25: 156 (1889); Hook. f. in Curtis's bot. Mag. t.7173 (1891); K. Schum. in Engl., Monogr. Afr. Pfl. 5: 53 (1900); R. A. Dyer in Flower. Pl. Afr. 30, t.1169 (1954). Type: Transkei, Kokstad, *Tyson* 1689 (BOL, lecto!; Z!; SAM!); Orange Free State, *Cooper* 900; Lesotho, *Cooper* 2001; Natal, *Fannin* 9.

H. cristata var. *geoides* Beauv. in Bull. Soc. bot. Geneva 2, 3: 133 (1911). Type: Transvaal, foothills of the Drakensberg near Shilovane, *Junod* 2856.

Suffrutex with several stems from a stout, woody rootstock; stems usually less than 30 cm tall, simple to laxly branched in second year, fairly laxly stellate-pubescent and with minute glands or minute gland-tipped hairs intermingled. *Stipules* linear-filiform or

linear-lanceolate, about 5 mm long and less than, or up to 1 mm broad, sparsely stellate-pubescent. *Leaves* shortly petiolate; blade elliptic, elliptic-oblong, ovate-elliptic or lanceolate, 2–6,5 cm long, 0,3–2,2 cm broad, crenate-dentate, crenations sometimes small and distant, concolorous, upper surface with impressed veins, fairly densely to sparsely pubescent with simple or 2- or more-rayed, bulbous-based hairs, lower surface with prominent veins and sparsely stellate-pubescent with hairs usually shorter than on upper surface; petiole 1,5–6 mm long. *Inflorescence* axillary and terminal, flowers usually solitary on long peduncles up to 5 cm long; pedicels short, about 3 mm long; bracts linear-filiform, 1–2 on peduncle and 2 at base of pedicel, about 1–3 mm long. Calyx 8–14 mm long,

lobed to midway or just beyond, stellate-pubescent without and usually intermingled with minute gland-tipped hairs. *Petals* 1, 1–1.9 cm long, "crimson", "red-orange", "orange", "red", upper third suborbicular, slightly broader than long, narrowing into a claw with infolded margins. *Stamens* united at base to a long stipe, free part of filaments hyaline, narrowly obovate, broader at apex, about 1 cm long, obscurely stellate on shoulders; anthers about 1 cm long, ciliate with basal portion overlapping dilated filaments. *Ovary* stipitate, 5-angled, densely stellate-pubescent, stellate pubescence on keel of angles shortly stalked; styles 6 mm long, minutely and sparsely hairy with short patent hairs. *Capsule* oblong-orbicular in outline, deeply 5-angled, roughly pubescent with short-rayed, stellate hairs and fringed on keel of angles with crowded, tentacle-like processes up to 7 mm long (developed from stalks of stellate hairs), calyx subpersistent at base, ultimately reflexed and withered to expose a 4 mm long stipe; seeds reniform-orbicular, plicate. Figs 1.4 & 2.1.

Found in grassveld on rocky slopes, in gorges and along rivers. Recorded from mountain grassland following the line of the Drakensberg from Mt Currie District in the Transkei northwards through Natal and the eastern Orange Free State, Piet Retief and Swaziland to the Soutpansberg in northern Transvaal.

CAPE.—Mt Currie: near Kokstad, *Haggarth* s.n.; *Tyson* 1689 (BOL); Mt Currie, *Goossens* 354.

O.F.S.—Vrede: 10 km S. of P.O. Vrede, *Acocks* 21947.

NATAL.—Lion's River: Zwarthof location, *Moll* 1143. Newcastle: Normandien, *Sim* 2884. Nkandhla: Nsuzi, *Gerstner* 603. Underberg: Springvale farm, *Sirey* 7697. Utrecht: 6 km S.E. of P.O. Groenvlei. *Codd & Dyer* 6280.

SWAZILAND.—Hhohho: Miller's Falls, *Compton* 26193; Pig's Peak, *Wells* 2023.

TRANSSVAAL.—Barborton: Saddleback Mtn, *Galpin* 434. Belfast: Dullstroom, *Noome* in TRV 20783. Carolina: Carolina, *Leipoldt* in TRV 18627. Ermelo: Athole Pasture Station, *Norval* 38. Groblersdal: 1.6 km S. of Nebo, *Acocks* 20859. Letaba: east slope Piesangskop, *Scheepers* 1013. Lydenburg: 12 km N. of Lydenburg, *Codd & De Winter* 3274. Middelburg: Tautenberg, *Young* 4189. Nelspruit: Schagen, *Liebenberg* 3335. Pietersburg: Haenertsburg, *Potts* 4696. Piet Retief: Piet Retief, *Galpin* 9633. Pilgrim's Rest: between Pilgrim's Rest and Sabie, *Rogers* 23216. Soutpansberg: Louis Trichardt, *Breyer* 24366; Downs, *Junod* 4237. Wakkerstroom: North Hill, *Galpin* 9809.

Until recently this species was unique in Southern Africa on account of the fringe of long processes on the angles of the capsule. In 1958 a new species was found on the Brandberg in South West Africa with similarly fringed capsule-angles. It was published as *H. merxmülleri* in 1961. The processes on this new species are longer and more hair-like than those on *H. cristata* and in many other respects these two species differ appreciably. For instance, the leaves of *H. merxmülleri* are suborbicular and the petioles usually well over 10 mm long, while in *H. cristata* the leaves are usually elliptic-oblong and the petioles 1.5–6 mm long.

From description there are 2 species in America that resemble ours in having fringed capsules.

2. *Hermannia merxmülleri* *M. Friedrich* in Mitt. Bot. StSamml., Münch. 4: 167 (1961); *M. Friedrich* et al. in F.S.W.A. 84: 16 (1969). Type: South West Africa, Brandberg, Zisabschlucht, *Merxmüller & Giess* 1664 (M, holo.; PRE!).

Shrub about 2 m high, branches stellate-tomentose with long, patent, minutely gland-tipped hairs intermingled. *Stipules* subulate, 2–6 mm long, stellate-pubescent. *Leaves* petiolate; blade broadly ovate-

orbicular, 1–3.5 cm long, 1.2–3.5 cm broad, crenate-dentate except at the subcordate base, apex rounded, truncate or emarginate, concolorous, densely stellate on both surfaces with short hairs, veins impressed above, prominent beneath; petiole 10–30 mm long, stellate-pubescent, often with patent gland-tipped hairs intermingled. *Inflorescence* of 1- to few-flowered cymes, axillary and terminal; peduncle 5–12 mm long, pubescent as on petiole. *Calyx* about 14 mm long, lobed to just beyond middle, roughly pubescent with small, stellate hairs, rays mostly short, some longer, from a minutely bulbous base. *Petals* glabrous, grey-green and purplish blue at the apex on inner face, 17–20 mm long, upper third suborbicular, narrowed into a long claw with infolded margins. *Stamens* with hyaline, narrowly obovate-cuneate, apparently glabrous filaments which are attached to the long stipe at base, free portion about 6 mm long; anther 8 mm long ciliate, pointed, overlapping filament at base. *Ovary* about 5 mm long, densely hairy with long-stalked, long-rayed, stellate hairs, stalks subulate or filiform; stipe about 6 mm long; styles 7.5 mm long. *Capsule* about 1.5 cm long, deeply 5-angled, crest of angles furnished with 2 to 3 series of long, filiform processes (elongated stalks of stellate hairs?), rest of capsule shortly stellate-pubescent; stipe partly hidden at base by persistent calyx and reflexed petals.

Found "among rocks on hillsides". Recorded from the slopes and gorges of the Brandberg, South West Africa.

S.W.A.—Omaruru: Brandberg, Zisabschlucht, *Merxmüller & Giess* 1664; White Lady Valley, *Macdonald* 588 (BM).

To date this remarkable species is known only from the Brandberg in South West Africa. It is the tallest known *Hermannia* in southern Africa, being 2 m tall. In the fringed angles of the capsule it resembles only one other species on the subcontinent, namely *H. cristata*, in which, however, the processes of the fringe are slightly stouter. In habit these two species differ widely, for in *H. cristata* the stems are under 30 cm tall and subherbaceous. For further differences see under *H. cristata* (p. 7).

3. *Hermannia sandersonii* *Harv.* in F.C. 1: 200 (1860); *Wood & Evans*, Natal Plants 1: 19, t.20 (1893); *K. Schum.* in Engl., Monogr. Afr. Pfl. 5: 60 (1900). Type: Natal, "Port Natal", *Sanderson* s.n. (TCD, holo.; PRE, photo.; K!; S!; PRE!).

Low suffrutex; stems many from a thick, woody rootstock, simple or laxly branched, more or less leafless in lower half, subdensely and coarsely hairy with bulbous-based stellate hairs, rays about 1 mm long, acute. *Stipules* ovate, ovate-lanceolate or linear-lanceolate, about 7 mm long, 1–3.5 mm broad at base, rather thick-textured (oily?), laxly stellate-pubescent dorsally. *Leaves* shortly petiolate; blade from fairly narrowly to broadly oblong-elliptic, or some leaves obovate to suborbicular, 2–5 cm long, 0.7–3.5 cm broad, discolorous, upper surface with impressed veins, subdensely to laxly stellate-pubescent, hairs few, long, acute and from a bulbous base, undersurface with prominent veins densely whitish to yellowish tomentose, tomentum of matted stellate hairs, margins crenate-dentate; petiole 2–6 mm long, stellate-pubescent. *Inflorescence* of a few 1–3-flowered cymes borne in the upper half; peduncles 2–10 mm long, shaggily stellate-pubescent; pedicels not readily distinguishable from peduncles, 3–10 mm long, pubescence as on peduncle; bracts linear-lanceolate to subulate, 2–5 mm long. *Calyx* about 7 mm long, lobed almost to middle, stellate-pubescent on the

strong, prominent ribs and margins, lobes deltoid. *Petals* yellow, recurved in upper half, about 9 mm long, about 6,5 mm broad in the broadly rounded upper third, narrowing to a 2 mm waist and produced into a claw with infolded margins of which the edges are membranous and obscurely hairy. *Stamens* about 6,5 mm long; filaments joined at base, hyaline, narrowly obovate, about 3 mm long with 1 or 2 stellate hairs on shoulders; anthers about 4,5 mm long, overlapping filaments for 1 mm. *Ovary* 2,5 mm long, 2 mm diam., 5-angled, densely hairy with sessile and stalked stellate hairs, stipe 5 mm long. *Capsule* about 9 mm long, 7 mm diam., 5-lobed and bluntly 5-umbonate at apex, pubescent with sessile and stalked hairs, shortly stipitate, with the persistent calyx like a disc at base. *Seeds* reniform-orbicular, black, plicate.

Found on grassy hills and in grassy gorges. Recorded from the Camperdown, New Hanover, Pietermaritzburg and Durban Districts of Natal.

NATAL.—Camperdown: Inchanga, Marloth 4090; Medley Wood 4654; 6536; Umlaas, Maurice Evans 548A (NH); Shongweni Dam, Ross 1292; 413 (NH). Durban: "Port Natal", Sanderson 9244; without exact locality, Gerrard 1117 (W). New Hanover: King's Hill Halt, Gordon-Gray 6320. Pietermaritzburg: in valley 5 km from Table Mtn, Stirton 1024.

This species is readily distinguished by its general appearance. The many, short, subherbaceous stems from a woody rootstock are more or less leafless in the lower half and bear comparatively large discolorous leaves and a few yellow flowers in the upper half. A collector records that the flowers develop in advance of the leaves.

H. sandersonii is poorly represented in herbaria and most of the specimens seen were collected in the last century.

4. *Hermannia seineri* Engl. in Bot. Jb. 55: 371 (1919). Syntypes: South West Africa, Otjitjika, Dinter 2871 (B†; SAM!); Epata, Trotha s.n.; Seiner 284; 390.

Stems procumbent, slender, long, wiry, laxly branched near base, obviously hoary-pilose intermixed with appressed stellate pubescence. *Stipules* narrowly linear-lanceolate, about 4 mm long, hoary-pilose. *Leaves* petiolate; blade narrowly ovate- to obovate oblong, 2–3,5 cm long, up to 9 mm wide, usually folded, subrotund at apex, broadly cuneate at base, upper surface roughly stellate-pubescent, lower surface stellate-pilose with long hoary hairs; margins obscurely serrate and densely hoary-pilose; petiole about 1 cm long. *Inflorescence* of simple 1-flowered cymes solitary in axils of leaves; peduncle slender, straight, 2–2,5 cm long, hoary-pilose; pedicels cernuous, slender, about 2–3 mm long; bracts about 3 mm long, narrowly linear to subulate. *Calyx* hoary-pilose outside and on margins, lobed to beyond middle, about 7 mm long, lobes 5 mm long. *Petals* "orange", "cream", about 5 mm long, broadly oblong to subglobose, narrowed at base into a short claw, margins inrolled on claw and basal portion of blade. *Stamens* with filaments broadly obovate, narrowing at apex to an acute connective, 2,5 mm long, sparsely pilose on shoulder; anthers erect, about 5,5 mm long, basal portion overlapping expanded filaments, sparsely pilose. *Ovary* about 2 mm long, sparsely minutely stellate with simple hairs intermixed; styles about 5 mm long, sparsely pilose. *Capsule* 6 mm long, hoary-pilose, 5-umbonate or shortly horned at apex. *Seeds* reniform, dark brown, several in a locule.

Found on level, well-drained sand in grassland and on loose sand dunes in north-eastern South West Africa and in Botswana.

S.W.A.—Otjitjika: Dinter 2871 (SAM); Omaramba Omatako, Schoenfelder 5190.

BOTSWANA.—Ngamiland: Pandamatanga road, c. 100 km S. of Kazungula on road to Nata, Verhagen & Barnard 162.

Before 1977 only two specimens had been seen of this species, Dinter 2871 (SAM) and Schoenfelder 190 (PRE), both with a hoary pubescence unusual for the genus. Not only did these specimens answer well to the description of *H. seineri*, but Dinter 2871 is a syntype of the species and Schoenfelder 190 had been matched with Dinter 2871 in B (now destroyed). Good material (Verhagen & Barnard 162) collected in Botswana during 1977 matched these specimens in detail and confirmed that *H. seineri* evidently is a good, well-defined species.

For *H. seineri* var. *latifolia* Engl. see under *H. eonii* (p. 10).

5. *Hermannia tomentosa* (Turcz.) Schinz ex Engl. in Bot. Jb. 55: 371 (1919); Burtt Davy, Fl. Transv. 1: 267 (1926) partly, excluding the synonym *H. johannisburgiana*; Wild in F.Z. 1: 542 (1960); M. Friedrich et al. in F.S.W.A. 84: 22 (1969), partly. Type: Transvaal, Magaliesberg, Zeyher 137 (LE!; PRE!; SAM!; W!; Z!).

Mahernia tomentosa Turcz. in Byull. mosk. Obshch. 31: 218 (1858); Harv. in F.C. 1: 219 (1860), excluding the description and the specimen cited (see note). Type: as above.

Hermannia brachypetala Harv. in F.C. 1: 202 (1860); K. Schum. in Bot. Jb. 10: 42 (1889); in Engl., Monogr. Afr. Pfl. 5: 86 (1900). Syntypes: Transvaal, Magaliesberg, Burke & Zeyher s.n. (S; PRE, photo.); Cape, "Zooloo Country" (sic), but should be Kuruman area, Miss Owen s.n. (PRE, photo.).

H. tomentosa var. *brevifolia* Engl. in Bot. Jb. 55: 371 (1919). Syntypes: several, including Dinter 277 (Z!; SAM!) and Range 1026 (SAM!).

Perennial, branches long, at least the outer decumbent and trailing, young branchlets stellate-tomentose, hairs mostly short, interspersed with longer, tufted bristles and rarely with short, gland-tipped hairs, tomentum sometimes disappearing leaving only tufted bristles. *Stipules* linear-acuminate to subulate, 2–5 mm long, tomentose. *Leaves* petiolate; blade ± oblong to narrowly oblong-elliptic, 8–50 mm long, 5–15 mm (rarely 18 mm) broad, rounded or subtruncate at apex, rounded to somewhat cuneate at base, margin obscurely to distinctly toothed except in lower third, stellate-tomentose on both surfaces, hairs very short, tomentum persisting at least on undersurface; petiole 3–15 mm long. *Inflorescence* of simple 1-flowered cymes, solitary in axils of leaves on branches of indeterminate growth; peduncle straight, 10–15 mm long, tomentose; pedicels cernuous, about 2,5–4 mm long, bracteate at base; bracts 2 or 3, sometimes 1 of these on peduncle, about 3 mm long, narrowly lanceolate-acuminate. *Calyx* lobed almost to base; tube about 2 mm long, lobes 4,5–6 mm long, reflexed in fresh flower, tomentose on outside and on upper portion of lobes within. *Petals* pink, mauve, off-white with deep pink base, or "yellow and red", shorter than calyx, more or less oblong-globose, narrowing at base into a claw, margins involute on claw and sometimes narrowly so on blade also, only obscurely lobed at base of blade, lobes not thickened but sometimes darker in colour, with short, appressed hairs within upper part of claw or base of blade; blade about 3 mm long, 2 mm broad with the margins sometimes partly inrolled; claw 1 mm long. *Stamens* with filaments broadly obovate, narrowing at apex to

an acute connective, 2,5 mm long, sparsely hairy on shoulders; anther erect, about 5,5 mm long, 1 mm broad near base, narrowing to an acute apex, basal portion overlapping filament for 2 mm, shortly and sparsely hairy. *Ovary* obovate or suborbicular, about 2,5 mm long, 1,75 mm broad near apex, densely tomentose in upper portion not covered by filaments; styles very slender, straight, more or less cohering to each other, up to 5 mm long, sparsely and shortly hairy in lower half. *Capsule* shortly and densely tomentose (off-white tomentum), about 5,5–7 mm long, 5 mm broad, obovate-oblong, more or less truncate or crowned with 5 short, rounded processes, rarely up to 2 mm long. *Seeds* (on dried specimens) reniform, brown, corrugated, usually under 2 mm long, about 3 maturing in a cell.

Found on grassy plains and on slopes of mountains and hills. Recorded from Transvaal, Orange Free State, northern Cape and from South West Africa, especially in southern and central areas; also in Botswana and Rhodesia.

CAPE.—Barkly West: near railway station, *Smith* 2328. Gordonia: Gembok Park, Mata Mata, *Wenger* 1493; *Story* 5482. Hay: Wolhaarkop, *Esterhuysen* 2350. Hopetown: Hope-town, *H. Bolus* 1833 (Z). Kimberley: Kimberley, *Acocks* 43. Kuruman: Wonderwerk, *Esterhuysen* 2247. Mafeking: Mafeking, *Brueckner* 518. Prieska: Prieska, *Bryant* 281. Vryburg: Palmyra, *Rodin* 3517.

O.F.S.—Boshof: Boshof, *Schweickerdt* 1106. Fauresmith: near Petrusburg, *Codd* 3401.

TRANSVAAL.—Without locality, *Holub* s.n. Bloemhof: Christiania, *Burt Davy* in Govt. Herb. 12786. Marico: Zeerust, *Leendertz* in TRV 11270. Middelburg: Loskopdam reserve, *Theron* 1585. Potchefstroom: Boskop, *Louw* 736. Pretoria: Magaliesberg, *Zeyher* 137; *Schlechter* 3593; Wonderboom Reserve, *Repton* 2887. Rustenburg: Rustenburg, *Meeuse* 10489. Schweizer Reneke: Schweizer Reneke, *Burt Davy* 12786; 1687. Soutpansberg: Waterpoort, *Moss* 4599. Waterberg: Warmbaths, *Collett* 515. Naboomspruit: Naboomspruit, *Galpin* M. 36.

S.W.A.—Gibeon: *Codd* 5868. Karibib: Karibib, *De Winter* 2445. A. Okahandja: Okahandja, *Dinter* 277 (Z). Okavango: Between Katwitwi & Makamba Camp, *De Winter* 3862. Rehoboth: Rehoboth, *Basson* 6. Warmbad: Ariamsvlei, *Ortendahl* 650. Windhoek: Auaasberge, *Merxmüller & Giess* 786.

This species is characterized by the long trailing branches with secund leaves and a strong taproot with long secondary roots spreading horizontally. The young branches and leaves are stellate-tomentose, the short fine tomentum usually persisting at least on the lower surface of the leaves.

Throughout the wide area of distribution, and especially where it overlaps with that of other species, occasional specimens are found that appear to be forms or hybrids of the species, for instance a small-leaved form occurs fairly frequently. Until a more in-depth study is possible these are here included under *H. tomentosa*. One such specimen is *De Winter* 3378, mentioned under *H. engleri* Schinz in F.S.W.A. 84: 14. *Dinter* 5164, also mentioned in F.S.W.A. l.c., approaches *H. minimifolia* form or hybrid of that species.

In the past this species has been confused with *H. lancifolia* Szyszyl. This is mainly due to Harvey, who in F.C. 1: 219 cites an unnumbered specimen of Burke & Zeyher from the Magaliesberg under *H. tomentosa* although it is obviously *H. lancifolia*. It has been established that *H. lancifolia* does not occur on the Magaliesberg and the locality description of the species must thus be considered to be incorrect. Burke & Zeyher did collect both these species. *H. tomentosa*, which grows on the Magaliesberg, is represented in their collections by Burke 314 and Zeyher 137, while *H. lancifolia*, which they collected before they reached the mountain, is represented by Burke 255 and Zeyher 107.

6. *Hermannia eenii* Bak. f. in J. Bot., Lond. 39: 126 (1901). Type: South West Africa, Damara-land, *Een* s.n. (BM, holo.; PRE, photo!).

H. angolensis K. Schum. in Warb. Kunene-Samb. Exped. 302 (1903); Excell & Mendonca in C.F.A. 1,2: 195 (1951); Wild in F.Z. 1: 543 (1960). Type: Angola, between Kubango and Kuito, *Baum* 514 (Z, holo.; PRE, photo!; K; S; W!).

H. longiramosa Engl. in Bot. Jb. 55: 365 (1919). Type: South West Africa, Grootfontein, *Engler* 6240.

H. seineri var. *latifolia* Engl., l.c. 55: 371 (1919). Syntypes: South West Africa, Otjosondjou, *Seiner* 459; Aris Aukas, *Dinter* 725 (SAM!).*

H. brandtii Engl. ex Dinter in Reprium nov. Spec. Regni veg. 18: 25, (1922). Based on *Dinter* 725 from Otavi,* nom subnud. *H. karakowiensis* ined., name on *Dinter* 7315 (PRE!; Z!).

Perennial, prostrate with long slender runners, coarsely stellate-pubescent, often intermixed with bristle-like, ± patent setae from a bulbous base, 1–2 to several in a cluster, especially obvious in young growth, hairs straw-coloured to bright yellow. *Stipules* linear- to narrowly ovate-acuminate, about 3 mm long, sparsely setose, setae up to 1 mm long from a bulbous base. *Leaves* petiolate; blade linear-oblong, lanceolate-elliptic to ovate-elliptic or oblong-elliptic, varying in size, sometimes on same plant (leaves on ultimate branchlets much smaller), 1–6,5 cm long, 0,4–2,5 cm broad, coarsely stellate-pubescent, from densely to sparsely so, more or less rounded at base, rounded, subtruncate or acute at apex, obscurely to distinctly crenate at least in upper half; petiole 2–20 mm long, coarsely, stellate or with tufts of setae (few hairs in a tuft). *Inflorescence* of 1-flowered cymes, axillary on long branches and crowded at apices of ultimate branchlets; peduncles slender, up to 3 cm long; pedicels short, up to 3 mm long; bracts 2–3 at apex of peduncle, linear-lanceolate, 2,5–4 mm long, 0,5–1 mm broad near base, setose or stellate. *Calyx* lobed almost to base, coarsely stellate outside and on upper portion of lobes within, tube about 2 mm long, lobes about 6 mm long. *Petals* usually pink, sometimes white or white with a dark patch near base, 3–6 mm long, shorter than calyx, oblong or oblong-obovate, obscurely clawed, about 4 mm long and 2 mm broad, margins slightly to clearly inrolled on both blade and claw, shallowly lobed at base of blade, inner surface of petals with minute appressed hairs about midway between marginal lobes, apex rounded to subtruncate. *Stamens* with obovate, hyaline filaments which are setose on shoulders, 2 mm long, 2 mm broad at apex with a short apicule, joined to anther near its base; anthers erect, about 6 mm long, basal portion overlapping expanded portion of filament for 1 mm, thence narrowing to an acute apex, minutely hairy. *Ovary* stellate-pubescent with bristle-like hairs which are sometimes golden-yellow and often concentrated at apex, minutely papillose under stellate pubescence; styles very slender, erect, about 6 mm long, with short, spreading hairs in lower half. *Capsule* coarsely stellate-pubescent and with bristle-like hairs especially at apex, about 5,5 mm long, 5 mm diam., obscurely 5-lobed, lobes with blunt apices, not produced into horns. *Seeds* brown, reniform, corrugated.

Found in sandy parklands, on dunes or in savanna. Recorded from the northern and eastern regions of South West Africa and the northern Cape where it

* *Dinter* 725, collected at Aris Aukas, and the same number collected at Otavi are represented in SAM. They are obviously not the same gathering, the former dated 1918-12-29 and the latter 1908-11-29, but they both fall within the range of *H. eenii* Bak. f.

borders on South West Africa and Botswana. Also in Botswana, Rhodesia, Zambia and Angola.

CAPE.—Gordonia: Kalahari Gemsbok National Park, Mata Mata, Werger 1824.

S.W.A.—Grootfontein: Auros, *Dinter* 5455; Simkue, *Story* 6151; Tsumeb, *Dinter* 7464; Olievenhof, *Merxmüller & Giess* 30141. Okahandja: Hochfeld, *Boss* in TRV 32832. Okavango: Makambo Camp, *De Winter* 3863; Kake Camp, *De Winter & Wiss* 4384. Otjiwarongo: N.E. of Otjiwarongo, *De Winter* 2845.

This species is distinguished from *H. tomentosa* by the leaves, even the young ones, being coarsely stellate-pubescent, often intermixed with bristle-like setae, and not finely stellate-tomentose as in *H. tomentosa*. The general colour of the plants is very variable; some appear grey, others golden yellow. In fresh specimens the leaves are crystalline. The setae, which are found in most parts of the plant, and especially on very young leaves, vary from whitish to golden yellow.

Forms or hybrids appear to occur in *H. eenii*, as in many other species of *Hermannia*. For example *Hanekom* 2230 from Barkly West District appears to be a hybrid between *H. tomentosa* and *H. eenii*.

7. *Hermannia boraginiflora* Hook., Ic. Pl. t. 597 (1843); Harv. in F.C. 1: 201 (1860); K. Schum. in Engl., Monogr. Afr. Pfl. 1: 267 (1926); Wild in F.Z. 1: 543 (1961). Type: Transvaal, Magaliesberg, *Burke* 293 (K, holo.; PRE, photo.; SAM!).

H. tephrocarpa K. Schum. in Notizbl. bot. Gart. Mus. Berl. 2: 304 (1899). Type: Transvaal, Lydenburg, *Wilms* 68 (K; PRE, photo.; Z).

Suffrutex, bushy, much branched from base; branches and branchlets suberect or ascending, stellate-pubescent or pubescent with short, patent, gland-tipped hairs, sometimes with stellate hairs intermixed, rarely with a few simple patent hairs as well. *Stipules* from under 1 mm to 4 mm long, up to 1.5 mm broad, subulate to deltoid-oblong. *Leaves* petiolate, blade elliptic, oblong or obovate-oblong, acute or more often broad at the apex and 3-toothed, up to 27×14 mm, upper leaves sometimes narrowly elliptic, entire and acute, 6–20 mm long, 3–4 mm broad, stellate-pubescent on both surfaces, more densely so on the lower, sometimes some gland-tipped hairs present and very minute scales; margins usually crenate-dentate at least in upper portion, upper leaves often entire; petiole 1.2–10 mm long. *Inflorescence* axillary, 1-flowered; peduncle stellate-pubescent or with usually gland-tipped, patent hairs, about 6–22 mm long, 2–3-bracteate at apex, sometimes with a fourth lower down on peduncle; bracts 1–2 mm long; pedicels 3–7 mm long, pubescent like the peduncles. *Calyx* lobed to beyond the middle, stellate-pubescent without, often intermingled with gland-tipped hairs, especially on margins of lobes; tube about 2 mm long; lobes deltoid-acuminate, about 5.5 mm long. *Petals* pink or off-white with a pair of oblong, deep pink patches on lower half of inner face, oblong-cuneate, about 6 mm long, lobed about midway, lobes ciliate and some pubescent on inner face of petal, lower half with inrolled margins. *Stamens* with hyaline, obovate-elliptic filaments, about 4 mm long, ciliate on the shoulders; anthers acute, about 5 mm long, ciliate, overlapping the filament for 1.5 mm. *Ovary* stipitate, stellate-pubescent, stipe 1–2 mm long; styles about 6 mm long. *Capsules* densely stellate-pubescent, about 6 mm long, 5 mm diam., truncate at apex with 5 pairs of horns about 1.5–2 mm long) at apex of sutures.

Occurs on rocky hillsides, on mountain slopes, in red loamy soils and on old lands. Found in the northern Cape, Natal, Swaziland and Transvaal. Also recorded from Rhodesia, Botswana and Mozambique.

CAPE.—Barkly West: Barkly West, *Acocks* 462. Hay: Hay, Griquatown, *Drège* in SAM 29814. Mafeking: Mafeking, *Brueckner* 265. Vryburg: Vryburg, *Rodin* 3496; *Codd* 1304.

NATAL.—Ubombo: coastal belt on margins of pans, *Tosh* 52 (NH).

SWAZILAND.—Lubombo: Stegi, Blue Jay Ranch, *Compton* 29561 (NBG).

TRANSVAAL.—Groblersdal: Marble Hall, *Codd & Verdoorn* 10372. Letaba: Merensky Nature Reserve, *Gilliland* 784. Lydenburg: West of Blyde River Canyon, *Leistner* 3264. Messina: Dongola, *Verdoorn* 2101. Middelburg: Loskopdam Reserve, *Theron* 1800. Pietersburg: Pietersburg, *Rogers* in TRV 15490. Potgietersrus: Potgietersrus, *Galpin* 8926. Pretoria: Magaliesberg, *Schlechter* 3656. Rustenburg: Rustenburg, *Story* 6054. Soutpansberg: Soutpan, *Obermeyer, Schweickerdt & Verdoorn*, 142. Waterberg: Naboomspruit, *Galpin* M 35.

Characterized by the roughly stellate-pubescent calyx and capsule.

In *Gilliland* 746 from Letaba, gland-tipped hairs are inconspicuous or absent. This may be an aberrant form. It approaches the east coast species *H. micropetala*, but its petals are rather long. It falls within the distribution area of *H. glanduligera* but has the stellate pubescence of *H. boraginiflora*.

8. *Hermannia glanduligera* K. Schum. in Verh. bot. Ver. Prov. Brandenb. 30: 232 (1888); in Engl., Monogr. Afr. Pfl. 5: 57 (1900); Wild in F.Z. 1: 545 (1961); M. Friedrich et al. in F.S.W.A. 84: 15 (1969). Type: South West Africa, Amboland, Olukonda, *Schinz* s.n. (Z, holo.; PRE, photo.; LEI; BOL; GRA!).

H. viscosa sensu Burtt Davy, Fl. Transv. 1: 267 (1926).

Perennial, bushy, much branched from base, 30–60 cm tall; branches and branchlets pubescent with 1- to several-celled glandular hairs and many gland-tipped hairs intermixed with some long, patent, pointed hairs. *Stipules* 0.75–2 mm long, up to 1 mm broad. *Leaves* petiolate; blade on upper branches more or less narrowly oblong, very variable in size and on some branches much reduced, ranging from about 6 mm×1.5 mm to 30×14 mm, rounded or shortly cuneate at base, usually broadly acuminate towards apex, margins serrate, coarsely and usually sparsely stellate-pubescent on both surfaces, with some glandular hairs intermixed and sometimes gland-tipped hairs present as well, especially along margins and with numerous, minute papillae on the surfaces, petiole 1.5–15 mm long, the lower longer. *Inflorescence* of 1-flowered cymes in axils of leaves, solitary but appearing racemose in specimens where leaves on ultimate branches are much reduced; peduncle usually short, 5–14 mm long, occasionally (as in the type) up to 25 mm long, persistent, 2–3-bracteate at apex (bracts under 1 mm long), pubescent with glandular or gland-tipped hairs and sometimes with long, pointed, patent hairs intermixed; pedicels 2–4 mm long, pubescence like that on peduncles. *Calyx* about 7 mm long, lobed to beyond middle, pubescent on outside mainly with glandular hairs, but sometimes stellate hairs present and long non-glandular pointed hairs as well; lobes pubescent inside with appressed, non-glandular hairs. *Petals* pale pink to pale violet, sometimes with a red base, narrowly oblong-cuneate or suborbicular-cuneate, 2–6 mm long, 1–2.5 mm broad in upper half, margins inrolled in lower half only, auricles thickened and infolded

with a thickened ridge between them, auricles and ridge densely to laxly setose. *Stamens* from about 6 to 10 mm long; filaments up to 4 mm long, hyaline, obovate, setose on shoulders; anthers up to 8 mm long, erect, pointed, overlapping filaments at base, sparsely patently pubescent (on a few specimens anthers aborted, blunt, about 1.5 mm long). *Ovary* stipitate at base (stipe up to 1.5 mm long), pubescent with short glandular hairs and with pointed setae along the sutures. *Capsule* up to 7 mm long and about as wide, glandular-hairy on surface between sutures, setae along sutures, blunt or with horns eventually up to 2 mm long; seeds more or less reniform, corrugated, granular and with minute papillae.

Found in sandy to semi-sandy bushveld of the warmer regions, usually in dry riverbeds, along streams or rivers, sometimes as a weed in lands or broken ground. Recorded from the drainage basin of the Okavango and Etosha Pan in northern South West Africa, through the northern and eastern Transvaal and Swaziland to Zululand. Also occurs in Botswana, Zambia and eastwards through Rhodesia and Malawi to Mozambique.

NATAL.—Umfolozzi: Umfolozzi River, *Wager* in TRV 22384; between Black Umfolozzi and Nongoma, *Acocks* 11671.

SWAZILAND.—Hlatikulu: Usutu Poort, *Compton* 30099.

TRANSVAAL.—Barborton: Komatipoort, *Marloth* 3452; Kaapmuiden, *Rogers* 25064; *Galpin* 745; Crocodile River Drift, *Bolus* 7685. Letaba: Kruger National Park, Letaba-laagwaterbrug, *Van der Schijff* 543; 2782; Mamaranda, *Breyer* in TRV 17607. Lydenburg: Driekop, *Meuse* 9297; Burgersfort, *Meuse* 9293. Messina: Messina, *Pole Evans* in Govt. Herb. 2940; 1703. Nelspruit: Research Station, *Liebenberg* 2725; Pretoriuskop, *Codd & De Winter* 4941. Pilgrims Rest: Pilgrims Rest, *Rauh & Schlieben* 9705. Potgietersrus: Maastroom, *Srey & Schlieben* 8661. Sibasa: Punda Milia, *Codd* 4234. Soutpansberg: Soutpan, *Obermeyer, Schweickardt & Verdoorn* 142; Mara, *Schlechter* 4616.*

S.W.A.—Okavango: between Shamvura and Kangongo, *De Winter* 4210. Ovamboland: Oshigambo, *Sylvii Soini* s.n.

The isotype gathering represented in the Leningrad Herbarium is not typical of the species. It must have been collected in optimum conditions. The leaves are all well developed, the branchlets straight and the peduncles much longer than usual.

K. Schumann includes this species under those with carpels not horned but they are sometimes shortly horned.

Giess 3178 from Kaokoland may belong here, but the specimen is incomplete and cannot be identified with certainty.

The species is characterized by glandular and gland-tipped hairs intermingled with long, pointed hairs on the branches, a lax, coarse, stellate pubescence on the leaves and the capsule with glandular setae only along the sutures. Noteworthy, too, are the short horns on the capsule and the thick auricles on the petals.

9. *Hermannia viscosa* *Hiern*, Cat. Afr. Pl. Welw. 1: 89 (1896); K. Schum. in Engl., Monogr. Afr. Pfl. 5: 87 (1900), as *viscida*; M. Friedrich et al. in F.S.W.A. 84: 22 (1969). Syntypes: Angola, *Welwitsch* 4709; 4710 (BM; PRE, photos!); 4704.

Suffrutex, intricately branched; branches predominantly glandular-pubescent, hairs short, spreading and only slightly swollen at apex, occasionally with stellate hairs intermixed. *Stipules* subulate, glandular-

pubescent, 2–3 mm long. *Leaves* petiolate; blade 10–25 mm long, oblong-obovate, usually broad at apex, narrowing slightly towards rounded base, serrate-dentate except near base, fairly densely pubescent with stellate and glandular hairs, stellate hairs few-rayed from a minute central scale, glandular hairs short, usually slightly longer and more conspicuous on margins and prominent veins; petiole glandular-pubescent, 5–20 mm long. *Inflorescence* of 1-flowered cymes, solitary in axils of upper leaves; peduncles about 10 mm long; pedicels up to 5 mm long; bracts small, subulate, about 1.5 mm long. *Calyx* 6–10 mm long, lobed to beyond middle, glandular and stellate-pubescent without. *Petals* “scarlet”, or “violet-rose turning almost purple”, about 6–8 mm long, shorter or about as long as calyx, more or less oblong, narrowed in lower third into a claw with infolded margins apparently glabrous, with 2-coloured ridges above claw on inner face. *Stamens* 6–7 mm long, filaments hyaline, broadly obovate-cuneate, ciliate on shoulders; anthers longer than filaments and overlapping them at base. *Ovary* densely pubescent, styles about 3 mm long. *Capsule* somewhat glabrescent, about 8 mm long, with 5 pairs of short horns.

Recorded from Kaokoland in South West Africa and northwards in Angola.

S.W.A.—Kaokoland: west of Otjihu, *De Winter & Leistner* 5691.

Differs from the related *H. glandulosissima* principally in the habit, being a low shrublet with intricate branches, not erect, with fairly short, slender lateral branches as in *H. glandulosissima*. Furthermore, the leaves of *H. viscosa* are larger, the petioles longer and the petals glabrous.

The description is based on the one specimen seen, *De Winter & Leistner* 5691. It answers well to the original description of the species and is cited in F.S.W.A. under *H. viscosa* together with *Merxmüller & Giess* 1432 and 1461.

10. *Hermannia glandulosissima* *Engl.* in Bot. Jb. 55: 370 (1919); M. Friedrich et al. in F.S.W.A. 84: 15 (1969). Type: South West Africa, Namib, Pforte, *Dinter* 182 (not traced).

Suffrutex, erect, over 30 cm tall, much branched, ultimate branchlets short, slender; branches and branchlets fairly densely pubescent with short, patent, glandular hairs, some of them gland-tipped, very rarely a few long, pointed hairs occur. *Stipules* narrowly deltoid to subulate, \pm 1 mm long, stellate-pubescent and usually with one long, pointed hair at apex. *Leaves* petiolate; blade narrowly to broadly oblong-obovate, 2.5–12 mm long, 1–6 mm broad, toothed in upper portion, densely stellate-pubescent, hairs short, spreading or suberect (tufted), especially on veins beneath; petiole 1–4 mm long, pubescent. *Inflorescence* axillary, solitary, 1-flowered; peduncle 5–9 mm long, 2–3-bracteate at apex; bracts about 1.5 mm long, more or less subulate, stellate-pubescent and with a few long, pointed hairs; pedicels 2–4 mm long, almost straight to cernuous, pubescent like the peduncle. *Calyx* about 7.5 mm long, tube about 1.5 mm long, lobes 6 mm long, outside stellate-pubescent over glandular papillae, inside the lobes are pubescent with appressed hairs. *Petals* narrowly to broadly oblong-spathulate, 3–4.5 mm long, up to 2 mm wide, margins inrolled on claw only, auricles at centre infolded, fairly thinly fringed with whitish, diaphanous setae. *Stamens* about 7 mm long; filament hyaline, obovate, 2.5 mm long, pubescent on shoulders;

* *Schlechter* 4616 (quoted by Engler as a syntype of *H. modesta* var. *elatio* K. Schum. subvar. *macropetala* Engl.) in Herb. Z is *H. modesta* sensu lat., while the specimens of this number in SAM and PRE are *H. glanduligera*.

anthers about 6 mm long, overlapping filaments for about 1 mm. *Capsule* 3–5 mm long, shallowly 5-lobed, mucronate at apex of lobes, glandular-papillate on surface, stellate or with clustered rather short setae on sutures; stipitate.

Recorded from Swakopmund District (eastern border) and Karibib northwards to the borders of Etosha and the eastern border of Kaokoland.

S.W.A.—Kaokoland: west of Otjitjekua, *Giess* 3178. Karibib: "Pforte", *Dinter* 181 (SAM), Sphinx, *Dinter* 8449. Kavango: Katuitui, *Giess* 9496. Omaruru: Hunabschlucht, *Boss* A47. Swakopmund: Arandis, *Boss* 2197.

Close to *H. glanduligera* and *H. viscosa* but differs from both mainly in the finer and denser pubescence on the leaves.

In the original description the locality of the type of *H. glandulosissima*, *Dinter* 182, is given as "Damaraland, Namib, bei Pforte, Kilom 82". This means it cannot be from Pforte in the Outjo district. This is confirmed by a specimen in SAM, *Dinter* 181, also from "Pforte, Kilom 82", but on this label is the information that it was collected on the "Reise Okahandja-Swakopmund". This places it, presumably, in the district Karibib.

Dinter 8449 was labelled *H. rotundifolia* Pillans sp. nov., by N. S. Pillans but this name was never published.

11. *Hermannia grisea* Schinz in Vjschr. naturf. Ges. Zurich 62: 676 (1917); Burtt Davy, Fl. Transv. 1: 267 (1926). Type: Transvaal, Manaka, Brakrivier, *Schlechter* 4631 (Z, holo.!, PRE, photo.!, K, photo.!, BOL!; PRE!; SAM!; GRA!).

H. sideritifolia Engl. in Bot. Jb. 55: 369 (1919), nom. illegit. Type: as above.

Suffrutex, about 60 cm tall, branched in lower half, stems reddish brown but covered with grey-stellate tomentum; branches virgate, finely grey stellate-tomentose and leafy in lower half, in upper half leaves much reduced, and pubescence reduced mainly to short simple, patent, gland-tipped hairs, some stellate hairs present. *Stipules* subulate, under 1 mm long. *Leaves* petiolate; blade narrowly oblong-elliptic, 1.5–4.5 cm long, 0.2–1 cm broad, densely and finely stellate-tomentose on both sides, margin sometimes with short gland-tipped hairs, entire or dentate except in the lower portion; petiole 1–6 mm long. *Inflorescence* axillary, solitary, 1-flowered, in axils of upper, much reduced, leaves and so appearing racemose; peduncles with short, patent, gland-tipped hairs, 15–21 mm long, minutely bracteate at apex; pedicels 2–6.5 mm long, pubescence same as on peduncles, but with stellate hairs as well. *Calyx* up to 9 mm long, densely and finely stellate-tomentose, glandular hairs obscured, lobes up to 6.5 mm long, inner face lined with appressed hairs. *Petals* 3–6 mm long, 2–3 mm broad in upper portion, \pm obovate-spathulate, margin inrolled on claw only, auricles not thickened but with pointed, diaphanous setae along the inner edge, inner central face minutely brown-papillate. *Stamens* with hyaline, obtrullate (kite-shaped) filaments, ciliate in upper portion, \pm 3 mm long; anthers about 7 mm long, with the basal portion overlapping the filaments, sparsely patently pubescent. *Ovary* shortly (0.5 mm) stipitate, 2.5 mm long, 1 mm diam., finely stellate-pubescent and glandular with tufted setae at the apex; styles \pm 5.5 mm long, sparsely pubescent in basal portion. *Capsule* 6–8 mm long, about 6 mm diam., densely and finely

stellate-tomentose (glandular hairs or papillae obscured), stipe short, short horns ultimately produced to about 1.5 mm long; seeds subreniform, corrugated and minutely granular to tuberculate.

Found on sandy ridges and flats and in brackish ground. Recorded from Waterberg and Soutpansberg Districts; also in Botswana.

TRANSVAAL.—Pretoria: Pienaars River, near Makapan's Stad, *Verdoorn* 2510. Soutpansberg: near Salt Pan, *Schweickerdt & Verdoorn* 553. Waterberg: Ons Hoop, *Codd* 8469; Ellisras, *Acocks* 8812.

Characterized by the finely stellate-tomentose stems and branches of which the upper portions become pubescent with short, gland-tipped hairs, the densely stellate-tomentose leaves which become reduced to bracts in the upper half giving the appearance of a raceme to the axillary 1-flowered inflorescences and the capsule which is finely stellate-tomentose.

12. *Hermannia solaniflora*, K. Schum. in Bot. Jb. 10: 43 (1888); in Engl., Monogr. Afr. Pfl. 5: 58 (1900); M. Friedrich et al. in F.S.W.A. 84: 21 (1969). Type: South West Africa, Hykamchab, *Marloth* 1200 (holo., not traced; PRE!).

Low, frutescent plant, 10–40 cm high with a few slender branches from or from near base; branches simple, densely to subdensely appressed stellate-pubescent. *Stipules* small, up to 1 mm long, subulate to oblong, acuminate, often obscured by the pubescence. *Leaves* all, or those in upper portion, often reducing markedly in size, petiolate; blade elliptic, narrowing slightly to base and apex or apex truncate or rounded and crenate, about 8 \times 4 mm, lower leaves usually broadly elliptic to oblong, crenate in upper half, often up to 12 \times 9 mm; stellate-pubescent on both surfaces, densely so beneath; petiole 1–3 mm long. *Inflorescence* of simple, 1-flowered cymes solitary in axils of leaves and appearing racemose towards ends of the branches because of reduced leaves; peduncles slender 10–15 mm long, persistent stellate-pubescent; pedicels cernuous, 1–3 mm long, usually more densely stellate-pubescent than peduncles. *Calyx* lobed to beyond middle, stellate-pubescent; lobes long, attenuate, 5–8 mm long, reflexed at one stage in open flower; tube about 2.5 mm long. *Petals* red, spatulate, about 6 mm long, 2.5–3.5 mm broad in upper half, margins inrolled on the claw, at one stage in open flower reflexed from the middle. *Stamens* with dark purple, erect anthers about 6–10 mm long, pubescent; filament obovate, hyaline, no pubescence seen, about 3 mm long, overlapped by anther base for about 1 mm. *Ovary* about 3 mm long, and 2 mm broad, pubescent with short, stellate or simple bulbous-based or gland-tipped hairs and at apex with long, acute hairs; cells 2-horned. *Capsule* with short, stellate and glandular hairs, with long, acute hairs at apex, horns 1–2.5 mm long.

Found in sandy beds of watercourses or ravines from Swakopmund to Kaokoland in South West Africa.

S.W.A.—Damaraland: Welwitschia, *Galpin & Pearson* 7469. Hereroland: Hereroland, *Dinter* 1495 (Z); *Dinter* 16 (Z). Kaokoland: Anabib, *Stor* 5742. Karibib: Between Okahandja and Swakopmund, *Dinter* 180 (SAM). Omaruru: Numas Ravine, Brandberg, *De Winter & Hardy* 8219; *Giess* 3610; 9150. Outjo: Outjo, *Giess, Volk & Bleissner* 6279. Swakopmund: Swakopmund, *De Winter & Hardy* 8028. Windhoek: between Windhoek and Walvis Bay, *Esdale* sub *Rogers* 15331.

Characterized by short petals which reflex, stellate-pubescent branches, shortly stellate-glandular and setose capsules with short horns and stipe, and long attenuate calyx-lobes.

13. *Hermannia minimifolia* M. Holzhammer in Mitt. bot. StSamml. Münch., 1: 349 (1953); M. Friedrich et al. in F.S.W.A. 84: 17 (1969). Type: South West Africa, Swakopmund, south of Kuiseb, Strey 2442 (M, holo.; PRE!).

Suffrutex, erect, up to 60 cm tall, ultimate branchlets short, slender, rigid, and divaricate, stellate-tomentose. *Stipules* about 1 mm long, stout, tomentose. *Leaves* not, or very shortly, petiolate; blade densely stellate-tomentose, on average about 2,5 mm long and 1 mm broad, usually shorter than 5 mm, broadly elliptic or obovate-cuneate, recurved, apex acute or truncate and 2-3-lobed, margins entire or very sparsely toothed in upper half; petiole very short or absent. *Inflorescence* axillary, 1-flowered; peduncle about 2 mm long, stellate-tomentose; pedicel about 3 mm long, roughly stellate-tomentose; bracts caducous. *Calyx* roughly stellate-tomentose without, lobed almost to base, tube about 2 mm long, lobes about 5 mm long, long-acuminate appressed hairy in upper portion within. *Petals* "dark brownish purple", about 4,5 mm long; limb oblong, margins somewhat incurved, lobed at the base; claw with involute margins, ridge on inner face of petal between lobes minutely setose. *Stamens* with broadly obovate, hyaline filaments, hairy on shoulders, about 2,5 mm long, 2 mm broad; anthers about 6 mm long, ciliate. *Capsule* about 5 mm long, subglobose, roughly stellate-tomentose, not horned; styles about 6 mm long, minutely hairy. *Seeds* 1-2 in a cell, reniform, about 2 mm wide.

Recorded from the dunes south of Kuiseb, South West Africa.

S.W.A.—Swakopmund: south of Kuiseb, Strey 2442.

Characterized by the very small, sessile, or almost sessile, leaves and the short, rigid, ultimate branches which become indurated.

Dinter 5164 approaches this species and may fall within the variation when more material is seen. The stipules, however, differ in not being stout. *Dinter* 5164 is mentioned in F.S.W.A. as an atypical representative of *H. engleri*. *Giess* 13426 also approaches *H. minimifolia* having the rather fleshy or stout stipules but the leaves are longer. Both *Dinter* 5164 and *Giess* 13426 differ from *H. engleri* mainly in the habit, the latter being a rounded bush, much branched from the base with long, slender branches.

14. *Hermannia engleri* Schinz in Vjschr. naturf. Ges. Zurich 55: 243 (1910), nom. nov.; M. Friedrich et al. in F.S.W.A. 84: 14 (1969). Type: South West Africa, Lüderitz, Awichab, *Dinter* 1085 (Z!; PRE, photo.!).

H. dinteri Engl. in Bot. Jb. 38: 591 (1907), non Schinz. Type: as above. *H. seitziana* Engl. in Bot. Jb. 55: 370 (1919). Syntypes: South West Africa, Sandverhaar, *Dinter* 1178 (SAM!); *Schaefer* 285.

Suffrutex, branched at base, forming a rounded bush 30-90 cm tall and about 1 m in diam.; branchlets many, slender, long, ascending, the outer decumbent, stellate-tomentose with short and long intermixed hairs. *Stipules* 1,5-3 mm long, linear or linear-subulate, tomentose, hairs erect at apex. *Leaves* petiolate; blade linear to narrowly oblong, 7-22 mm long, 1,5-7 mm broad, apex broadly

acuminate, rounded or truncate and lobed, base rounded or broadly cuneate, both surfaces finely stellate-tomentose with hairs appressed to subspreading (mostly under 0,5 mm long), veins usually strongly impressed above and prominent beneath; petiole 1,5-5 mm long, stellate-tomentose with hairs mostly over 0,5 mm long. *Inflorescence* consisting of 1-flowered, axillary cymes, solitary in axils of leaves; peduncle 2-7 mm long, stellate-tomentose with short hairs; pedicels 2-4 mm long, stellate-tomentose with hairs slightly longer than on peduncle; bractoles 0 or minute, up to 0,5 mm long. *Calyx* tube about 1,5 mm long, lobes 5-7 mm long, stellate-tomentose without with hairs both short and long, some being up to 0,5 mm long, obscurely appressed hairy in upper part within. *Petals* mauve, pink, oblong-cuneate, about 4 mm long, 2 mm broad, claw about 1,5 mm long, margin inrolled on claw and base of blade, lobed at apex of claw, lobes almost meeting on the ventral surface which bears a ridge (sometimes obscure) between the lobes and is glabrous or microscopically hairy on the ridge. *Stamens* with broadly obovate, hyaline filaments, about 2 mm long, 2 mm broad near apex, with hairs on shoulders, apical connective short; anthers about 5 mm long, overlapping filaments at base, ciliate. *Ovary* densely stellate-tomentose (with rays sometimes over 0,5 mm long), 4 mm long, 4 mm broad near apex, with 5 blunt horns at apex; ovules probably 6 in a cell. *Capsule* densely stellate-pubescent with 5 short, blunt horns about 1 mm long.

Found in sand in the dry southern areas of South West Africa.

S.W.A.—Bethanien: Sandverhaar, *Dinter* 1178 (SAM); 4220; *Pearson* 4660 (SAM; BOL). Keetmanshoop: Gründorn, *Dinter* 5054. Lüderitzbucht: Awichab, *Dinter* 1085 (Z). Warmbad: Swartkop-Noachabeb, *Orientahl* 391.

This species is described as forming a low bush up to 1 m in diameter, a feature which cannot very well be judged from herbarium specimens. Authentic specimens in herbaria show many slender branches from the base and this may help to identify the species. To date it has been recorded only from the dry southern areas of South West Africa. Closely related species are *H. tomentosa* (see notes under that species) and *H. guerkeana*. *H. guerkeana* is recorded from the higher rainfall areas further north and does not show many slender branches from the base.

In the F.S.W.A. two specimens, *De Winter* 3378 and *Dinter* 5164, are mentioned under *H. engleri* as differing somewhat from the typical. *De Winter* 3378 could rather be a form of *H. tomentosa*, while *Dinter* 5164 is nearest *H. minimifolia* (see note under that species).

15. *Hermannia guerkeana* K. Schum. in Verh. bot. Ver. Brandenb. 30: 231 (1888); K. Schum. in Engl., Monogr. Afr. Pfl. 5: 57 (1900); Wild in F.Z. 1: 542 (1961); M. Friedrich et al. in F.S.W.A. 84: 15 (1969). Type: South West Africa, Omadongo, Amboland, *Schinz* 601 (Z!; PRE, photo.!).

H. hereroensis Schinz in Vjschr. naturf. Ges. Zürich 55: 242 (1910). Type: South West Africa, Waterberg, *Dinter* 355 (Z!; PRE, photo.!).

Suffrutex, erect, up to 60 cm tall, with outer branches sprawling in sand, branches with a fairly smooth, stellate tomentum, rarely with a few longer bristle-like hairs intermixed. *Stipules* linear-subulate, 1-3 mm long, tomentose. *Leaves* petiolate; blade linear-elliptic to narrowly oblong or oblong-elliptic, acute, rounded or truncate at apex, somewhat

cuneate to rounded at base, finely and thinly stellate-tomentose on both surfaces, entire or toothed in upper half, often folded, 10–25 mm long, 3–8 mm broad; petiole 1.5–4 mm long. *Inflorescence* of 1-flowered cymes solitary in the axils of the leaves; peduncles 9–20 mm long; pedicels 1–2 mm long, cernuous; bracts 2–5, about 1 mm long, narrowly deltoid-subulate. *Calyx* about 7 mm long, divided to below middle, densely stellate-pubescent, hairs short from a scaly base. *Petals* "pink", "reddish" or "plum-coloured", oblong-cuneate, 3 mm long, 1.75 mm broad, margins inrolled in lower, claw-like half with thickened auricles or horns about midway which almost meet on inner face of petal, inner face slightly ridged where blade and claw meet, minutely setose on the ridge, midrib distinct. *Stamens* with membranous, broadly obovate filaments which are setose on shoulders, about 2 mm long, 1.75 mm broad; anthers about 4–6 mm long, sparsely patently pubescent, overlapping filaments at base. *Ovary* densely stellate-pubescent (hairs short), 5-lobed, lobes rounded at apex; styles 5, stiff, thread-like, cohering, about 5 mm long. *Capsule* densely stellate-tomentose, 3–5 mm long, 5-umbonate at apex.

Recorded from Kaokoland, Outjo, Otjiwarongo and Grootfontein in South West Africa, as well as the northern regions of Botswana. Found on sandy ground.

S.W.A.—Grootfontein: Karakowisa, *Dinter* 7301; Tsumkwe, *Giess* & *Snyman* 11033. Kaokoland: Andana Karvapa, *Merxmüller* & *Giess* 1358A. Otjiwarongo: near Otjiwarongo, *Rodin* 2719; S. of Okaputa, *Tölken* & *Hardy* 957; Waterberg, *Dinter* 355 (Z). Outjo: Etosha Pan, *Walter* 423 (WIND); Etosha National Park, *Le Roux* 1109; Namutoni, *Le Roux* 458.

BOTSWANA.—Maun, *Erens* 330; *Story* 4641.

H. guerkeana is near to and may be confused with *H. engleri* and *H. tomentosa*. It occurs in the northern, slightly moister, regions of South West Africa as compared with *H. engleri* which is found in the dry south, while *H. tomentosa* occurs in the northern Cape, the Transvaal, Orange Free State and central South West Africa.

16. *Hermannia micropetala* Harv. in F.C. 1: 201 (1860); K. Schum. in Engl., Monogr. Afr. Pfl. 5: 58 (1900); Wild in F.Z. 1: 543 (1961). Type: Mozambique, Delagoa Bay, *Forbes* s.n. (K, holo.; PRE!).

H. phaulochroa K. Schum. in Notizbl. bot. Gart. Mus. Berl. 2: 303 (1899). Syntypes: Mozambique, *Schlechter* 11576 (PRE!; LE!; Z!; BOL!; W!); *Junod* 29.

Suffrutex about 60 cm tall, with slender, terete, woody stem; branches terete, densely stellate-pubescent. *Stipules* small, about 1–3 mm long, stellate-pubescent. *Leaves* petiolate; blade elliptic-oblong to obovate-oblong, narrowing slightly to base, somewhat acuminate to apex or broad and rounded or subtruncate at apex, sometimes toothed in upper portion, stellate-pubescent on both surfaces, sometimes glabrescent at least in part on upper surface; petiole 2–6 mm long, stellate-pubescent. *Inflorescence* of 1-flowered cymes, solitary in axils of leaves; peduncle 7–14 mm long, usually persistent, stellate-pubescent, minutely bi-bracteate at apex; pedicels 2–6 mm long, pubescent with stellate or tufted hairs. *Calyx* about 6.5 mm long, lobed to about 1.5 mm from base, densely stellate-pubescent on outside. *Petals* pink to reddish, about 4 mm long, rounded at top and narrowing into a claw in lower half, blade with margins not inrolled, claw with margins inrolled and the two lobes at apex somewhat thickened. *Stamens* about 7 mm long; filaments hyaline, obovate, broadly acuminate at apex into the connective, bearing a few \pm obscure hairs

on shoulders; anthers acuminate to an acute apex, brown-pubescent along margins besides bearing a few, scattered, patent hairs, overlapping filaments at base. *Ovary* very shortly stipitate at the base, stellate-pubescent, without horns; styles about 9 mm long, thread-like, cohering in a straight, erect column. *Capsule* densely stellate-pubescent with a pair of short, blunt horns at apices of sutures.

In sandy patches on flats in the Ingwavuma District of Natal. Also found in the Maputo area and on Inhaca, Mozambique.

NATAL.—Ingwavuma: Ndumu Game Reserve, *Ward* 1992; at the pont on Pongola River, *Vahrmeijer* & *Tölken* 976; Ndumu Hill, *Pooley* 498.

Characterized by the fairly rough stellate pubescence without obvious gland-tipped hairs, the small petals with thickened lobes at the apex of the claw, and the short blunt horns on the capsule which is stellate-pubescent. It is close to *H. boraginiflora* from which it differs mainly in the absence of obvious gland-tipped hairs.

17. *Hermannia amabilis* Marloth ex K. Schum. in Bot. Jb. 10: 42 (1888); K. Schum. in Engl., Monogr. Afr. Pfl. 5: 54 (1900); M. Friedrich et al. in F.S.W.A. 84: 12 (1969). Type: South West Africa, Hykamkab, *Marloth* 1213 (PRE!; BOL!).

H. tenuipes Engl. in Bot. Jb. 55: 363 (1919). Type: South West Africa, Hoabes, *Dinter* 1439 (Z!).

Suffrutex, lax to bushy, up to 75 cm tall, leafy in lower half, in upper half leaves much reduced; branches subslaxly pubescent with gland-tipped, usually short hairs. *Stipules* 1.5–5 mm long, on upper bract-like leaves down to 1 mm long. *Leaves* petiolate; blade narrowly oblong to oblong or ovate-acuminate, 1–6 cm long, 1.5–10 mm broad or in ovate leaves up to 18 mm broad near base, upper bract-like leaves 2–10 mm long, 0.5 mm broad, subulate, stellate-tomentellous on both surfaces, sometimes intermixed with longer, gland-tipped hairs especially along margins, rarely subslaxly stellate-pubescent on both surfaces, petiole 1.5–2.5 mm long, in upper bract-like leaves about 10 mm long, glandular-pubescent. *Inflorescence* of 1-flowered, axillary cymes, apparently in long, terminal racemes owing to the marked reduction of upper leaves; peduncle very slender, straight, patent to subpatent, 2–3, 5 cm long, glabrous; pedicel cernuous, sometimes finely pubescent, about 5 mm long. *Calyx* about 7.5 mm long, obscurely pubescent without, lobed to midway or just beyond. *Petals* longer than calyx, white to pale pink with a coloured patch ("pink", "red" or "mauve") just below middle, about 17 mm long, 5 mm broad in apical portion and from there narrowing to base, claw about 4 mm long, margins inrolled. *Filaments* obovate, long-cuneate, mucronate, about 5.5 mm long; anthers about 4.5 mm long, overlapping filament for almost 1 mm. *Ovary* stipitate, oblong-obovate; stipe 1.5 mm; styles filiform, about 5–10 mm long, straight. *Capsule* about 5 mm long and 6 mm diam. near apex, oblong or narrowing slightly towards the stipitate base, pilose along sutures, not horned.

Found in gorges and dry riverbeds in South West Africa.

S.W.A.—Kaokoland: Otjihiu, *De Winter* & *Leistner* 5680; Okawerowe, *Merxmüller* & *Giess* 1426; Anabib, *Story* 5755; Otjinungua, *De Winter* & *Leistner* 5772; Sesfontein, *De Winter* & *Leistner* 5872. Karasburg: Karasburg, *Dinter* 2802 (SAM). Omaruru: near Welwitschia, *Hardy* & *De Winter* 1452; Brandberg, *Strey* 2650. Outjo: *Giess* 3928. Swakopmund: Welwitschia, *Galpin* 7600.

18. *Hermannia modesta* (Ehrenb.) Mast. in F.T.A. 1: 232 (1868); K. Schum. in Engl., Monogr. Afr. Pfl. 5: 83 (1900); Burtt Davy, Fl. Transv. 1: 268 (1926); Wild in F.Z. 1: 548 (1961); M. Friedrich et al. in F.S.W.A. 84: 17 (1969). Type: Saudi Arabia, near Djeddah (or Dschidda) towards Mecca, *Ehrenberg* s.n.

Tricanthera modesta Ehrenb. in Linnaea 4: 402 (1829). Type: as above.

Hermannia arabica Hochst. & Steud. ex Fisch. in A. B. Mey. & Ave'-Lall., Ind. Sem. Petrop. 6, Animadv. Bot. 9 (1840); Hiern, Cat. Afr. Pl. Welw. 1: 89 (1896). Syntypes: Saudi Arabia, Dschidda, *Ehrenberg* s.n.; *Schimper* 928 (K; PRE, photo!; LE!).

H. filipes Harv. in F.C. 1: 206 (1860). Type: Cape, "Zulu Country" (sic), in fact Kuruman area, "Miss Owen" s.n. (TCD, holo.).—var. *elatiorel* K. Schum. in Verh. bot. Ver. Prov. Brandenburg. 30: 235 (1888). Type: South West Africa, Amboland, Olukonda, *Schinz* s.n. (not traced but *Schinz* 585 from Olukonda is in BOL! & Z!).

H. modesta var. *elatiorel* (K. Schum.) K. Schum. in Engl., Monogr. Afr. Pfl. 5: 84 (1900). Type: as for *H. filipes* var. *elatiorel*.—subvar. *virgatissima* Engl. in Bot. Jb. 55: 367 (1919). Syntypes: South West Africa, Damaraland, Tsub, *Dinter* 2038 (SAM!); Okahandja, *Dinter* 431 (SAM!; Z!).—subvar. *brevicornis* Engl., l.c. (1919). Syntypes: Transvaal, Mara, *Schlechter* 4613 (K; PRE, photo!; BOL!; Z!); Nazareth, *Schlechter* 4479 (Z!; BOL!).—subvar. *macropetala* Engl., l.c. (1919). Syntypes: South West Africa, Okahandja, *Schlechter* 4616 (BOL!; Z!*); Engler 6189 (K; PRE, photo!); Otavi, *Dinter* 902 (SAM!).—subvar. *mediopetala* Engl., l.c. 368 (1919). Syntypes: South West Africa, Windhoek, *Dinter* 1254 (Z!); Okaputa, *Engler* 6207 (not seen).—var. *tsumebensis* Engl., l.c. 368 (1919). Type: South West Africa, Tsumeb, *Dinter* 3008 (SAM!).

H. kirkii Mast. in F.T.A. 1: 233 (1868); K. Schum. in Engl., Monogr. Afr. Pfl. 5: 84 (1900); Wild in F.Z. 1: 547 (1961). Syntypes: Mozambique, *Peters* s.n.; Lupata, Senna, *Kirk* s.n. (K; PRE, photo!); S. Central Afr., *Baines* s.n.

H. lugardii N.E. Br. in Kew Bull. 1909: 94 (1909); Burtt Davy, Fl. Transv. 1: 268 (1926); Wild in F.Z. 1: 547 (1961), in syn. Syntypes: Botswana, Kwebe Hills, *Lugard* 142; Mrs. *Lugard* 125 (K; PRE, photo!).

H. atrosanguinea Dinter in Reprium nov. Spec. Regni veg. 18: 251 (1922). Syntypes: Waldaui, *Dinter* 551a (SAM!; Z!); Otjihua, *Dinter* 551 (SAM!; Z!); Kuibis, *Dinter* 1182 (SAM!); Büllsporter Fläche, *Dinter* s.n.

H. holubii Burtt Davy, Fl. Transv. 1: 42, 268 (1926). Type: Transvaal, Mara, *Schlechter* 4613 (K; PRE, photo! BOL!; Z!) which is one of the syntypes of subvar. *brevicornis*).

Suffrutex, appearing annual but often persisting for a few years, flowering early in first year, stems erect, branching from near base, branches ascending or spreading-ascending; stems, branches, petioles and peduncles usually pubescent with short, patent, gland-tipped hairs, sometimes intermixed with distinct stellate hairs or stellate only and occasionally long, pointed, spreading hairs present as well, rarely some branchlets glabrescent. *Stipules* from about 1 mm to 2,5 mm long, linear-acute to subulate, sparsely stellate-pubescent. *Leaves* petiolate; blade variable, from more or less linear, narrowing slightly to base and apex, to oblong-elliptic, 6–40 mm long, 1–12 mm broad, usually sparsely stellate-pubescent, glabrescent, or gland-tipped hairs and bulbous-based hairs present, margins entire or distinctly toothed, apex acute or broad and rounded; petiole 1–12 mm long. *Inflorescence* of 1-flowered cymes, solitary in axils of leaves; peduncle 10–35 mm long, hardly distinguishable from the pedicels; pedicels 3,7 mm long, becoming cernuous; bracteoles aborted. *Calyx* persistent, stellate-pubescent, becoming translucent with age, sparsely pubescent with gland-tipped hairs, lobed to about, or just below midway, about 4,5 mm long. *Petals* "blood-red", "pale red", "pink", "deep orange", "crimson", "purple", mostly appearing deep violet in

pressed specimens, about 5–12 mm long, margin slightly inrolled on claw only, 4–6 mm broad near apex, narrowing slightly to the base. *Stamens* with obovate, hyaline filaments, pubescence obscure on shoulders; anthers erect, 4–8 mm long, overlapping the filament for about 1 mm, acute, sparsely ciliate. *Ovary* stipitate (stipe about 1,5 mm long), sparsely pubescent with gland-tipped hairs and longer hairs along the sutures and a few stellate hairs inter-mixed or stellate-pubescent with a few gland-tipped hairs intermixed, very shortly horned. *Capsules* 5–12 mm long, 4–7 mm broad, pubescent with short gland-tipped hairs and longer acute hairs on the sutures and a few stellate hairs present or predominantly stellate-pubescent with a few gland-tipped hairs present; horns usually under 2 mm long, spreading, stipe about 2 mm long. *Seeds* reniform, corrugated and finely granular with tubercles developing.

Found in dry, warm, sandy regions, mostly in open, sparse vegetation, often along roads in dry riverbeds and on old lands. Recorded from Beaufort West in the Cape northwards through the northern Cape, parts of the Orange Free State, Natal and Transvaal and into South West Africa. Also found in Botswana and northwards to Egypt and Arabia.

CAPE.—Beaufort West: Beaufort West, *Brueckner* 234. Gordonia: Gordonia, *Leistner* 1831. Hay: Hay, *Acocks* 2067; 17675; Upington, *Schlieben*, 10432. Kenhardt: Kenhardt, *Wasserfall* 1138. Kimberley: Kimberley, *Leistner* 2273. Kuruman: Kuruman, *Leistner* 2214. Prieska: Prieska, *Acocks* 12641. Vryburg: Vryburg, *Burtt Davy* 13675; 13776. Warrenton: Warrenton, *Leistner* 1261.

O.F.S.—Bloemfontein: Bloemfontein, *Potts* 7550. Boshof: Boshof, *Burtt Davy* 12893.

NATAL.—Lower Umfolozi: Umfolozi Game Reserve, *Ross* 2026.

TRANSVAAL.—Bloemhof: Bloemhof, *Theron* s/669. Letaba: Shilovane, *Junod* 6220. Lydenburg: Lydenburg, *Barnard* 488. Pietersburg: Pietersburg, *Schlechter* 4479. Pilgrims Rest: Pilgrims Rest, *Acocks* 16760. Potgietersrus: Potgietersrus, *Meeuse*, 9569. Soutpansberg: Mara, *Schlechter* 4613; Messina, *Mauve* 4415; Salt Pan, *Schweickerdt* & *Verdoorn* 486; 652.

S.W.A.—Gibeon: Gibeon, *Basson* 172; 161; *Van Vuuren* & *Giess* 1073. Gobabis: Gobabis, *Wilman* 402. Grootfontein: Grootfontein, *Merxmüller* & *Giess* 1799; *De Winter* & *Giess* 6783; *Dinter* 5319; Tsumeb, *Naegelsbach* in TRV 36298; *Dinter* 7450. Karibib: Karibib, *De Winter* & *Hardy* 7968; *Marloth* 1309. Kaokoland: Kaokoland, *Story* 5867; *De Winter* & *Leistner* 5374; 5166. Keetmanshoop: Keetmanshoop, *De Winter* 3253; *Dinter* 4863. Lüderitz: Lüderitz, *Kinges* 2146. Okahandja: Okahandja, *Dinter* 2703, *Otiwarongo*, *Bradfield* 171; 419. Okavango: Okavango, *De Winter* & *Mara* 4962. Ovambo: Ovambo, *De Winter* & *Giess* 6844. Rehoboth: Rehoboth, *De Winter* 3499; *Acocks* 18159. Swakopmund: Swakopmund, *Giess* 3005; *Codd* 10581. Windhoek: Windhoek, *Dinter* 4411; *Wilman* 427; *Merxmüller* 859.

From the long list of synonyms and the several varieties and subvarieties described, it is obvious that attempts to circumscribe discrete taxa in this complex have failed. It is noteworthy, for instance, that the type of *H. holubii* Burtt Davy, *Schlechter* 4613, is also a syntype of *H. modesta* var. *elatiorel* subvar. *brevicornis* Engl. (*Schlechter* 4613 in BOL differs from a specimen with the same number in K in having broader leaves). Much of the variation may be ascribed to hybridization.

A Venda name "Ishitoni sha" is noted on one of the specimens.

19. *Hermannia tigrensis* Hochst. ex A. Rich., Tent. Fl. Abyss. 1: 74 t. 17 (1847); K. Schum. in Engl., Monogr. Afr. Pfl. 5: 85 (1843); Mast. in F.T.A. 1: 233 (1868); Wild in F.Z. 1: 546 (1960), as *tigrensis*. Type: Ethiopia, dist. Tigre, *Schimper* 812 (K; PRE, photo!; LE!).

* *Schlechter* 4616 in PRE is *H. glanduligera* K. Schum., but in Z it is *H. modesta*.

H. mildbraedii Dinter & Engl. in Bot. Jb. 39: 590 (1907); M. Friedrich et al. in F.S.W.A. 84: 16 (1969). Type: South West Africa, Okahandja, Dinter s.n. (Z!; PRE, photo.!; K (as No. 487).

H. tenella Dinter & Schinz in Vjschr. naturf. Ges. Zürich 55: 241 (1910). Type: South West Africa, Waterberg, Dinter 354 (Z!; PRE, photo.!).

H. pseudo-mildbraedii Dinter & Engl. in Bot. Jb. 55: 369 (1919). Syntypes: South West Africa, Okahandja, Dinter 2566 (SAM!); Waldau, Dinter 522 (SAM!).

Annual, very slender, branched from near base; branches slender, spreading-ascending to arcuate-ascending, subdensely stellate-pubescent, hairs few in a group and of different lengths ($\pm 0,5$ mm long). *Stipules* subulate to linear, acuminate, 1,5–2,5 mm long, rarely up to 5 mm long (often on same plant). *Leaves* petiolate; blade narrowly to broadly ovate-acuminate, varying much in size on same plant, 10–35 mm long, 3–15 mm broad, rounded, and usually broadest, at base, broadly acuminate to an acute apex, obscurely to clearly serrate, sparsely to subdensely stellate-pubescent on both surfaces, hairs few in a group (sometimes reduced to 2) and of different lengths; petioles 1–4 (–12) mm long. *Flowers* axillary, solitary, yellow-orange, dull red, brick-red or cream with a dark centre, borne on thread-like peduncles; peduncle about 20 mm long, glabrous or pubescent in upper portion; pedicel usually short, from under 1 mm to 2 mm long, rarely up to 5 mm long, stellate-pubescent; bracts none or very small and early caducous. *Calyx* lobed to beyond middle, translucent, stellate-pubescent without; tube 1–1,5 mm long; lobes deltoid-acuminate, 2–2,5 mm long. *Petals* oblong to narrowly oblong, narrowing at base into a claw, 3,5–5,5 mm long, 1,5–2 mm broad, margins not inrolled or obscurely to clearly so on claw. *Filaments* obtrullate, about 2 mm long, pubescent on shoulders, translucent; anthers erect, about 2 mm long, acute at apex, rounded at base, very shortly overlapping filament at base (sometimes coloured). *Ovary* stipitate, minutely stellate-pubescent, about 1 mm long and almost 1 mm broad, lobes with 2 acute apices; styles very slender, erect, cohering, apices recurved; stipe about 0,5 mm long, distinct. *Capsule* about 5 mm long, 4 mm diam., shallowly 5-lobed at the apex, lobes 2-horned; horns 1,5–3,5 mm long.

Found in pockets of soil between rocks on koppies and mountains. Recorded from the northern half of South West Africa. Also in Angola and northwards to Ethiopia and Eritrea.

S.W.A.—Kaokoland: near Ohopoho, *De Winter & Leistner* 5346. Karibib: Ameib, *De Winter & Hardy* 8086; 8087; Klein Ameib, *Dinter* 7076. Okahandja: Okahandja, *Dinter* 4614; Waldau, *Dinter* 522 (SAM). Omaruru: Brandberg, *De Winter & Hardy* 8218. Outjo: Paresis Mountain, *Barnard* 175.

A range of material from South West Africa has shown that the length of the horns on the capsules may vary considerably, namely from 1,5–3,5 mm. *H. mildbraedii*, which has been distinguished from *H. tigrensis* by its longer horns, is therefore not upheld. A Rich. in Tent. Fl. Abyss uses the spelling *tigrensis*, while Hochstetter's list, Masters in F.T.A. and Kew Index give *tigrensis*. F.Z. retains the original spelling, i.e. *tigrensis*, as does F.S.W.A. in the note under *H. mildbraedii*. It appears that, according to Article 73 G (b) of the Code, it should be *H. tigrensis*. In Z *Dinter* 457 is indicated as the type of *H. mildbraedii* but there is no evidence to support it.

20. *Hermannia linearifolia* Harv. in F.C. 1: 205 (1860); K. Schum. in Engl., Monogr. Afr. Phl. 5: 79 (1900); Burt Davy, Fl. Transv. 1: 268 (1926). Syn-

types: Cape, Winterveld, between Nuwejaarsfontein and Ezelsfontein, *Drège* s.n. (K; PRE, photo.!; S); Orange River, *Burke & Zeyher* s.n. (TCD; PRE, photo.!); Somerset, *Barber* s.n. (PRE!).

H. fasciculata Bak. in Refug. Bot. 5, t. 289 (1873). Type: Cult., originally collected by Cooper in the Cape.

Bushy suffrutescent, 15–60 (–100) cm high, usually heavily browsed; stems minutely and densely grey scaly, new growth viscid with minute papillae and occasional stalked glands, otherwise glabrous. *Stipules* subulate, 0,5–1 mm long, deciduous. *Leaves* clustered on short, abbreviated shoots, sessile or shortly petiolate; blade varying in length in each cluster, 5 mm to about 12 mm long, very narrowly obovate, plicate, giving the appearance of being linear, microscopically pitted and with minute viscid papillae, otherwise glabrous; petiole 0,5–3 mm long. *Inflorescence* of 1-flowered cymes in pseudoracemes at the ends of the slender, ultimate branchlets; peduncles aborted or 1–3 mm long, viscid and with a few glands; bracteoles minute, about 0,5 mm long; pedicels usually glabrous, 2–4 mm long. *Calyx* about 6 mm long, lobed to middle or just beyond; glabrous and somewhat viscid with minute papillae, lobes deltoid-acuminate with the finely and densely ciliate margins incurved in upper portion. *Petals* about 1 cm long, “deep wine-red”, “red”, “brick-red”, “mauve” or occasionally clear yellow, oblong-obovate in upper two-thirds, produced into a claw with incurved margins in lower third, glabrous. *Stamens* adhering to stipe at base, free portion about 7 mm long; filaments hyaline, narrowly obovate, overlapped by anther base about as long as anthers. *Ovary* minutely papillate, about 1,5 mm long, stipitate; stipe about 1,5 mm long; styles 2,5 mm long. *Capsule* oblong-globose, about 6 mm long, 5 mm broad, with a 4 mm long stipe at base surrounded by the persistent calyx-tube, 5 pairs of spreading horns at apex, horns glabrous, 1–5 mm long.

Found among dolerite rocks, on hill slopes in calcareous sandy country and near pans. Recorded from Oudtshoorn and Uitenhage northwards through Cradock and Middelburg to the south-western Orange Free State, Christiana in the Transvaal, Kuruman in the northern Cape and in Botswana.

CAPE.—Barkly West: Holpan, *Acocks* 108; Danielskuil, *Acocks* 251. Cradock: near Rayners Koppie, *Acocks* 11920; Zebra Nat. Park, *Muller* 571; *Brynard* 28; *Liebenberg* 7238. Gordonias: Kakaup Pan, *Leistner* 2047. Herbert: Ramah, *Wenger* 1300. Kimberley: Merbou Siding, *Moran* s.n.; Warrington, *Adams* in PRE 48804; 48806. Kuruman: Kuruman, *Marloth* 1129. Middelburg: near town, *Gill* 127; *Flanagan* 1378; Grootfontein Agric. College, *Verdoorn* 1459; Rosemead Junction, *Sim* sub *Galpin* 5636. Oudtshoorn: near de Rust, *Dahlstrand* 1209. Richmond: Vlakplaat, *H. Bolus* 13772. Somerset East: Somerset East, *Barber* s.n. Uitenhage: Winterhoeksbergen, *Ecklon & Zeyher* 109. Victoria West: Melton Wold Estate, *Smith* 2438. O.F.S.—Boshof: Boshof, *Leistner & Joynt* 2664; *Burt Davy* in Govt. Herb. 10822. Fauresmith: Fauresmith, *Pole Evans* 1616; Koffiefontein, *Codd* 3421. Jacobsdal: Honeyestkloof, *Schweickhardt* 1154.

TRANSSVAAL.—Christiana: Bloemheuwel, *Burt Davy* in Govt. Herb. 11273.

BOTSWANA.—Without exact locality, *Holub*, s.n. (BOL).

This species is characterized by its clustered, almost needle-like leaves, and by the more usual stellate-pubescent being almost entirely replaced by glutinous scales and papillae which glisten in sunlight and cause the plant to be sticky when crushed. A paste made of the crushed parts is said to be used to close wounds and relieve pain and this accounts for the common name “Pleisterbos”. This species is usually referred to as “Rooi Pleisterbos”, but since the flower colour varies in the species and can be pure

yellow occasionally, it is not very apt. *H. linearifolia* belongs to the group in which the petals are not strongly twisted.

21. *Hermannia helianthemum* K. Schum. in Bot. Jb. 10: 44 (1889); in Engl., Monogr. Afr. Pfl. 5: 83 (1900); Burtt Davy, Fl. Transv. 1: 267 (1926), partly excluding *Holub* s.n.; M. Friedrich et al. F.S.W.A. 84: 15 (1969). Type: South West Africa, Usakos, *Marloth* 1237 (PRE, lecto!; SAM!; BOL!).

Suffrutex 30–60 cm high, virgately branched, branches slender, woody at base, stellate-tomentose. *Stipules* subulate or conduplicate, stellate-tomentose, 1,5–5 mm long. *Leaves* petiolate; blade linear-elliptic to narrowly ovate-oblong, densely stellate-tomentose on both surfaces, 16–34 mm long, 4–11 mm broad, usually broadly acuminate at apex, sometimes rounded and occasionally, on same plant, dentate at broad apex, usually rounded at base, margins entire or obscurely dentate, nerves prominent beneath, 3 basal nerves of which the two lateral ones (i.e. on each side of midrib) run only to about halfway up leaf, leaves reduced to bracts in upper portion of the ultimate flowering branches; petiole 5–11 mm long. *Inflorescence* of 1-flowered cymes in the axils of upper, reduced leaves, appearing racemose, the only distinction between peduncle and pedicel being that the latter is more densely stellate-tomentose; peduncle about 5–7 mm long; pedicel 1,5–3,5 mm long. *Calyx* about 6 or 7 mm long, lobed to about middle, stellate-tomentose outside, lobes appressed pubescent within. *Petals* "pale" to "deep pink", about 6–8,5 mm long and 2,5–4,5 mm broad, \pm oblong-cuneate, the margin inrolled only along the short, 1,5–2,5 mm long, claw which is glabrous. *Stamens* with obtrullate, very thin, hyaline filaments, with a few hairs on the shoulders, 2,5–4,5 mm long, 1,25–3 mm broad in upper half; anthers about 5 mm long, ciliate. *Ovary* densely stellate-tomentose with longer hairs at the apex, or subglabrescent in lower portion, about 3,5 mm long, stipe 1 mm long, with anther bases cohering to form a ring around it; style filiform. *Capsule* shortly horned;

Found on sandy flats near Garies and on granite slopes in the Omaruru, Karibib and Okahandja, districts of South West Africa, and in Namaqualand, Cape.

CAPE.—Namaqualand: Garies, *Esterhuysen* 1297.

S.W.A.—Karibib: Anschluss, *De Winter & Hardy* 7985. Okahandja: Usakos, *Marloth* 1237; Okagava, *Dinter* 6937. Omaruru: near Uis mine, *De Winter* 3165. Swakopmund: Wildreservat, *Jensen* 202 (WIND).

Characterized by the raceme-like inflorescence, the stellate tomentum on all parts, short horns to the capsule, pink, often pale pink, petals drying parchment colour, sometimes with violet patches.

The epithet *helianthemum* ending in "-um" is correct, because it is called after the genus *Helianthemum*.

In the original description K. Schumann cites only two specimens, *Marloth* 1237 and 1238. In Engl., Monogr. Afr. Pfl. 583 these two numbers are cited and indicated as being in the Berlin Herbarium. Specimens of *Marloth* 1238 in SAM and BOL are *H. comosa*, which could never be confused with *H. helianthemum*. It must be assumed that the specimen of *Marloth* 1238 in B, which was destroyed during the war, represented *H. helianthemum*.

22. *Hermannia damarana* Bak. f. in J. Bot., Lond. 39: 127 (1901); M. Friedrich et al. in F.S.W.A. 84: 13 (1969). Type: South West African, Damaraland, 1879, T. G. Een s.n. (BM, holo.; PRE, photo.!).

H. lindequistii Engl. in Bot. Jb. 39: 589 (1907). Type: South West Africa, between Okahandja and Otzisasu, *Dinter* s.n. (not traced).

Suffrutex 30–40 cm tall, stems woody, much branched, with grey bark; branchlets finely stellate-tomentose, hairs short, glutinous. *Stipules* up to 6 mm long, linear-subulate. *Leaves* shortly petiolate; blade narrowly to broadly oblong-obovate, about 3,5 \times 0,7 mm to 30 \times 9 mm, finely, densely and shortly stellate-tomentose (hairs somewhat glutinous), rounded or acute at apex, narrowing slightly to a rounded or cuneate base, margin usually entire, midrib and veins prominent beneath, usually 2 arising from base, one on each side of the midrib; petiole 1–4 mm long. *Inflorescence* of 1-flowered, axillary cymes; peduncle up to 15 mm long, shortly stellate-tomentose, 2–4-bracteate at apex; pedicels 2–3 mm long, stellate-tomentose with slightly longer hairs than on the peduncle. *Calyx* about 6 mm long, tube \pm 3,5 mm, lobes \pm 2,5 mm long, shortly stellate-tomentose without, and lobes with appressed hairs on the inner face, usually with five prominent nerves running from apex of lobes to base. *Petals* orange-red, oblong to narrowly oblong-spathulate, 7–10 mm long, some narrowly inrolled only on claw, others in same flower with somewhat infolded margins all the way, no auricles at apex of claw, glabrous on inner face. *Stamens* with oblanceolate-linear filaments \pm 4 mm long, glabrous; anthers \pm 4 mm long, overlapping filament for about 1 mm, ciliate. *Ovary* very shortly stipitate, \pm 2,5 mm long, shortly stellate-tomentose, hairs rather longer at apex; styles about 5 mm long. *Capsule* about 6 mm long, 3 mm diam., shortly and densely stellate-tomentose, eventually shortly horned at sutures, horns about 1,5 mm long.

Found in limy soils. Recorded from the Omaruru, Okahandja and Gobabis districts of South West Africa and eastwards into Botswana.

S.W.A.—Damaraland: Een s.n. (BM). Gobabis: Gobabis, *De Winter* 2508; Steinhausen, *Dinter* 2784 (SAM). Okahandja: Springbokvlakte, *Giess, Volk & Bleissner* 6322a. Okahandja: Okomita, *Dinter* 508 (Z). Omaruru: Omaruru, *Dinter* 7494. Without precise locality, *Bradfield* 428.

BOTSWANA.—60 km N.W. of Serowe, *Wild & Drummond* 7293.

Characterized by the short calyx lobes, the 5 prominent ribs on the calyx (outside), the fine, short, stellate tomentum, the three prominent basal nerves on the undersurface of the leaves and the stellate-tomentose capsule with very short horns.

23. *Hermannia gariepina* Eckl. & Zeyh., Enum. 49 (1834); Harv. in F.C. 1: 202 (1860); K. Schum. in Engl., Monogr. Afr. Pfl. 5: 80 (1900); F.S.W.A. 84: 14 (1969). Type: Cape, Boschmansland, near Orange River, *Ecklon & Zeyher* 384 (SAM!; S!; PRE!).

H. racemosa E. Mey. in Drège, Zwei Pfl. Doc. 192 (1843), nom. nud. based on *Drège* 3279 (PRE!; LE!; Z!).

H. exstipulata E. Mey. ex Harv. in F.C. 1: 202 (1860); K. Schum. in Engl., Monogr. Afr. Pfl. 5: 59 (1900). Type: Cape, Namaqualand, Orange River Mouth, *Drège* s.n. (TCD, holo.; PRE, photo.!).

H. truncata Schinz in Vjschr. naturf. Ges. Zürich 55: 241 (1910). Type: South West Africa, Graspoort, *Dinter* 1087 (Z!).

H. gariepina Eckl. & Zeyh. var. *dentata* Engl. in Bot. Jb. 55: 364 (1919). Type: Silverfontein, *Drège* 3279 (PRE!; LE!; Z!).—var. *integrifolia* Engl. in Bot. Jb. 55: 364 (1919). Syntypes: South West Africa, Range 177; 882 (SAM!); *Dinter* 1124; 1079 (Z!); *Engler* 6696.

H. nivea Schinz in Vjschr. naturf. Ges. Zürich 70: 218 (1925). Type: South West Africa, Kleinfonteiner Fläche, *Dinter* 3734 (PRE!; Z!).

Shrublet 22–75 cm tall, much branched, branches ascending or divaricate, densely and finely stellate-

tomentose with short, greyish white hairs. *Stipules* 0,75–2 mm long, thick in texture and densely stellate-tomentose with short greyish white hairs, sometimes caducous. *Leaves* shortly petiolate; blade rather thick in texture and densely stellate-tomentose with short, grey hairs, variable in shape and size, elliptic-cuneate to obovate—or oblong-cuneate, broadest just above middle or at the apex, about 7 to 20 mm long, margin entire or crenate at the apex, base cruncate or sub-rounded, apex broadly acuminate or truncate and often shallowly 3-lobed; petiole often folded trough-shaped, 1–5 mm long, rather thick in texture and densely stellate-tomentose with short hairs. *Inflorescence* of 1-flowered cymes, solitary in axils of leaves, upper subtending leaves sometimes much reduced in size giving the appearance of racemes; peduncles 2,5–6 mm long, densely stellate-tomentose with short hairs; pedicels 3–5 mm long, distinguishable from the peduncle by the coarser stellate pubescence, hairs over 0,5 mm long; bracts minute or wanting. *Calyx* lobed almost to base, stellate-pubescent with hairs rather long (0,5–1 mm), tube 1,5–3 mm long, lobes 4,5–7 mm long. *Petals* pink, “purplish” or “violet”, 6,5–9 mm long, 2,5–6 mm broad; blade narrowly oblong to suborbicular, narrowing slightly into a claw in lower third, margins sometimes minutely ciliate, glabrous within, claw with slightly inrolled margins. *Stamens* with hyaline, obovate filaments which either narrow gradually or abruptly to apex and base and are glabrous or setose on shoulders; anthers 3,5–5 mm long, ciliate with sparse, short hairs, overlapping filament for 1,5 mm. *Ovary* about 2,5 mm long, 2 mm diam. with short papillose hairs on surfaces and setose or stellate along sutures and at apex; stipe 1,5 mm long; styles 5 mm long, slender, erect, exerted from the closed mature flower for about 2 mm. *Capsule* about 5 mm long, usually hidden in the persistent calyx and petals, obscurely 5-angled, surface papillose, sutures setose and stellate with a blunt lobe or short horn at apex, up to 2 mm long; stipe 1,5 mm long. *Seeds* brown, reniform, corrugated (and sometimes scaly?).

Found in sandy semi-desert areas. Recorded from the Kenhardt District and northern Namaqualand in the Cape northwards to Warmbad, Lüderitz and Kaokoland in South West Africa.

CAPE.—Kenhardt: Kakamas Veld Reserve, *Acocks* 16360; near Pofadder *Esterhuysen* 1250. Namaqualand: Springbok, *Dumoulin* 4; Silverfontein, *Drège* 3279; Schakalswater, *M. Schlechter* 3; Orange River Mouth, *Drège* s.n.

S.W.A.—Kaokoland: Cape Frio, *Giess* 9079; south of Mōwebucht, *Merxmüller & Giess* 30662. Lüderitz: Haalenberg, *De Winter & Giess* 6161; Klinghardtgebirge, *Dinter* 3948; Aus, *Dinter* 6039. Warmbad: Vioolsdrift, *Merxmüller & Giess* 3671.

Characterized by the dense, fine, whitish, stellate pubescence of the branches, leaves and peduncles contrasting with the coarse stellate pubescence of the pedicels and calyx. The length of the hairs on the calyx varies considerably being long and shaggy on some specimens and not so long on others. The leaf shape and margin varies from elliptic-cuneate with entire margins to oblong-cuneate with a truncate and 3-lobed apex. Two forms of petals and filaments are found. The petals have either a narrow, oblong blade or a semi-orbicular blade with or without a ciliate margin, while the filaments which are broadest near the apex, either narrow gradually to base and apex or narrow abruptly and so may be taken to be somewhat cruciform.

Drège 3279, the type of var. *dentata*, is also the type of the nomen nudum *H. racemosa* E. Mey. in

Drège, Zwei Pfl. Doc. 192 (1843). Specimens of *M. Schlechter* s.n. from Schakalwater in Z and LE bear the name *H. maximiliana* Schltr. n. sp. In Z and PRE there are specimens of *Dinter* 6039 named *H. kurtiana* Schinz. This name was never published. The specimen is *H. gariepina*. Specimens of *Schlechter* 11374 in LE and Z bear the name *H. conaclada* K. Schum. which was evidently also not published. It too, is *H. gariepina*. The common name “Koerkassie” is recorded by Dumoulin.

24. *Hermannia complicata* Engl. in Bot. Jb. 39: 588 (1907). Type: South West Africa, Jakalswater, *Dinter* 1460 (Z, holo.!, PRE, photo.!).

Suffrutescent, leafy, dwarf bush, many-stemmed, about 20 cm tall, much branched from base, the whole plant grey stellate-tomentose, part of branchlets obscurely lineate. *Stipules* 1–2,5 mm long, rather thick and persistent, stellate-tomentose and with a few long hairs at apex. *Leaves* petiolate; blade narrowly to broadly oblong-cuneate, sometimes broadest at apex, from about 5×2 mm to 20×10 mm, stellate-tomentose on both surfaces; coarsely crenate in upper half or at apex only, cuneate portion entire; petiole 2–10 mm long, grey stellate-tomentose. *Inflorescence* of 1-flowered, axillary cymes, usually for whole length of the branchlet; peduncle 2–5 mm long, persistent but not indurated and spine-like; pedicels about 3 mm long, curled, slightly thicker and with denser tomentum than on peduncle. *Calyx* lobed to just beyond middle, stellate-pubescent to stellate-tomentose outside, lobes sparsely appressed pubescent within, tube 2–3 mm long, lobes 2,5–3,5 mm long. *Petals* “pink”, about 8 mm long, narrowly oblong, somewhat cuneate at base, margin narrowly inrolled in cuneate basal part, thin-textured, not thickened in centre, glabrous in specimens dissected. *Stamens* united at base around stipe; filaments narrowly obovate, hyaline, pubescent on shoulders, about 3 mm long; anthers 4 mm long, pointed, ciliate. *Ovary* with a 1,5 mm long stipe, subglobose, about 1,5 mm long, with 10 erect setose horns, papillose and stellate on surface, setose along sutures; ovules about 14. *Capsule* about 3 mm long, 3 mm broad, stipitate, papillose and stellate-pubescent on surface, setose along sutures, with 10 long, spreading to recurved setose or pilose horns 4–10 mm long.

Found on the edge of the Namib in semi-desert conditions. Recorded from Lüderitz District northwards to Welwitschia in South West Africa.

S.W.A.—Lüderitz: Between Helmeringhausen and Aus, *Kinges* 2223. Omaruru: Welwitschia, *Boss* 2183; *Galpin & Pearson* 7575; Brandberg, *Giess* 1957. Swakopmund: Usakos, *Dinter* 6847; between Okahandja and Swakopmund, *Dinter* 160 (SAM); between Walvisbaai and Swakopmund, *Strey* 2504.

Characteristically a small, rounded, entirely grey stellate-tomentose bush about 20 cm tall, branched from the base with slender branches. The leaves are coarsely crenate in the upper half and the ten horns on the capsule are long, pilose and spreading to recurved.

In F.S.W.A. this species is put in synonymy under *H. affinis*, a species which it resembles closely and which differs mainly in being a low bushy plant branched from the base, with branchlets which become less readily indurated and spine-like.

A specimen in BOL, *Miss W. Tucker* s.n., from the sand dunes south of Doornpoort, may be *H. complicata*, but the material is not sufficient for identification.

25. *Hermannia trifurca* L., Amoen. Acad. 6, 90 (1760); Sp. Pl. ed. 2: 942 (1763), as *trifurcata*; Syst. Veg. 610 (1784); Cav., Diss. t. 178, fig. 2 (1788), as *trifurcata*; Jacq., Schoenbr., t. 125 (1797); DC., Prodr. 1: 495 (1824), as *trifurcata*; Thunb., Fl. Cap. ed. Schult. 503 (1823); as *trifurca*. in F.C. 1: 205 (1860), as *trifurcata*. Type: "Cap. b. Spei", Linn. Herb. Cat. No. 854 (LINN, holo.; PRE, photo.).

H. bicornis Eckl. & Zeyh., Enum. 49 (1834). Type: Cape, "Piketberg", Ecklon & Zeyher Enum. No. 385 S; PRE, photo.! PRE!). *H. hiliaris* (Eckl. & Zeyh.) Hochr. in Annu. Conserv. Jard. bot. Genève 11 & 12: 2 (1907).

Mahernia incana Eckl. & Zeyh., Enum. 49 (1834). Type: Cape, between Saldanha Bay and Bergrivier, Ecklon & Zeyher Enum. No. 388 (PRE!).

M. hiliaris Eckl. & Zeyh. l.c. 49 (1834). Type: Cape, "Brackfontein", Clanwilliam, Eckl. & Zeyh. Enum. No. 389 (S; PRE, photo.!; TCD; PRE!).

Suffrutex, erect, woody, much branched, ultimate branchlets becoming indurated and spiky; branchlets scaly to minutely stellate-scaly, ridged in part. *Stipules* subulate to linear acute, 1.5–2.5 mm long. *Leaves* sessile or shortly petiolate, clustered on abbreviated shoots or single on the ultimate elongated shoots; blade linear to linear-cuneate, varying in size in each cluster, 6–25 mm long, 1.5–5 mm broad, rounded, acute or truncate at apex and often 3-toothed, densely to sparsely pubescent with, usually, minute stellate hairs, rays appressed and short, rarely long, margins entire, rarely toothed below tridentate apex. *Inflorescence* of 1-flowered cymes in the axils of upper leaves or arranged in fairly long terminal (pseudo-) racemes, flowers cernuous and secund; peduncle usually aborted or very short but occasionally up to 5 mm long, bi-bracteate at apex, stellate-pubescent; bracts subulate to linear, 1–3 mm long; pedicels usually 3–5 mm long when peduncle is not obvious, otherwise ranging from 1.5–4 mm, stellate-pubescent. *Calyx* 6–8 mm long, lobed to just beyond middle, subluxly stellate-pubescent, usually denser in lower portion, the hairs short or long, lobes densely ciliate with tufted hairs. *Petals* "mauve", "purple", "pink to wine-red, ageing blue", 7–11 mm long, suborbicular to broadly oblong-elliptic in upper half, narrowed below into a claw with infolded margins, glabrous. *Stamens* 7–8 mm long; filaments hyaline, oblong-obovate to narrowly oblong-cuneate, apparently glabrous, adhering at base to stipe; anthers ciliate, 4–5 mm long with the base overlapping the dilated filament. *Ovary* stipitate, 5-lobed, scaly and pillose, papillae longer on keels of lobes, about 1.5 mm long; stipe about 1.5 mm long; styles 6–7 mm long, eventually shortly exserted. *Capsule* 5-lobed, about 7 mm long, 6 mm broad, stipitate at base, apex with 5 pairs of spreading horns, keel of lobes and horns villous; stipe about 2 mm long; horns at first short, eventually up to 5 mm long.

Found from Worcester in the western Cape northwards through Namaqualand to the Klinghardt Mountains in South West Africa.

CAPE.—Calvinia: S.W. of Soetwater, farm Lokenburg, *De Winter & Verdoorn* 9012. Ceres: Ceres, *Pienaar* s.n. Clanwilliam: Clanwilliam, *Schlechter* 4397; 5056; *Galpin* 10731; Brakfontein, Ecklon & Zeyher Enum. No. 389; Citrusdal, *Liebenberg* 4336. Malmesbury: "Saldanhabay", *Drege* s.n. (S); Ecklon & Zeyher Enum. No. 388; Darling, *Hutchinson* 230. Namaqualand: without precise loc., *H. Bolus* in Herb. Norm. 441; Springbok, *Van der Schijff* 8127; 16 km S.E. of Arris, *Marloth* 12409; Steinkopf, *Marloth* 12224. Piketberg: Piketberg, Ecklon & Zeyher Enum. No. 385; near Bergrivier station, *Boucher* 82; between Veldrif and St. Helena Bay, *Marsh* 1276; Pickeniers Kloof, *Leipoldt* 19862. Vanrhynsdorp: Klaver, *Andreare* 490; Vredendal, *Thompson* 1010; *Hall* 3809. Worcester: Worcester, *Van Breda & Joubert* 1811; "Karee Bergen", *Schlechter* 8283; Hex River Valley, *Tyson* 688.

S.W.A.—Lüderitz: Klinghardtberge, Spitzkuppe Sud, *Watmough* 881.

This woody much branched shrub is characterized by the linear leaves which are usually 3-toothed at the apex, although sometimes very shallowly so, and the drooping, bell-shaped flowers secund towards the apices of the branchlets. The petals are reminiscent of flies' wings and fold together to give a truncate appearance to the flower. Often the filiform styles are shortly exserted. The short, broad, 5-lobed capsules, partly concealed by the persistent perianth, are made conspicuous by the pairs of pilose horns spreading horizontally from the apices of the lobes.

A common Hottentot name for this species is "Koerhassie".

With regard to the epithet "*trifurca*", not only did Linnaeus use it in the original description but, according to Latin scholars, it is more correct than "*trifurcata*" (private letter to N. S. Pillans from Capt. Salter).

26. *Hermannia affinis* K. Schum. in Verh. Bot. Ver. Prov. Brandenburg. 31: 180 (1890); in Engl., Monogr. Afr. Pfl. 5: 81 (1900); M. Friedrich et al. in F.S.W.A. 84: 11 (1969), for the greater part. Type: South West Africa, Lüderitz, "between Angra Pequena and Aus", *Schinz* 1113 (Z!; PRE, photo.).

H. windhukiana Engl. in Bot. Jb. 39: 588 (1907). Type: South West Africa, Windhoek, *Dinter* 851 (Z; PRE, photo.).

H. spinulosa Engl. in Bot. Jb. 55: 365 (1919). Type: South West Africa, Inachab, *Dinter* 1077 (Z; PRE, photo.).

H. squarrosa Dinter ex Range in Reprium nov. Spec. Regni veg. 36: 262 (1934), nom. nud. based on *Dinter* 6040 (Z!; PRE, photo.!; PRE!; SAM!).

Suffrutex, with woody stems and branches, branchlets varying in colour from pale yellow, metallic, cinnamon-brown to plum-coloured, thick and squarrose to slender and virgate but all with ultimate branchlets becoming bare, indurated and spine-like (the persistent peduncles usually not indurating as in *H. spinosa*), at first minutely glandular hairy, covered by dense stellate pubescence which, at least on some twigs, is cinnamon-coloured and appears powdery, rarely with some gland-tipped hairs as well. *Stipules* 1.5–3 mm long, persistent, tomentose and with a few long hairs at apex. *Leaves* petiolate; blade usually oblong-cuneate, sometimes oblong-elliptic, coarsely but shallowly lobed in upper half, some leaves entire, often broadest at apex, 8–30 mm long, 4–15 mm broad at centre or near apex, densely stellate-tomentose, stellate hairs from a scaly base; petiole 3–6 mm long, tomentose. *Inflorescence* of 1-flowered, axillary cymes; peduncle 3–4 mm long, pedicel 1.5–4.5 mm long; bracts at apex of peduncle small, 0.5 mm long. *Calyx* 7–10 mm long, lobed to beyond middle, tube 3 mm long, lobes 7 mm long, stellate-tomentose without, sparsely pubescent within, ciliate. *Petals* in shades of red and purple, about 9 mm long, 2–3 mm broad, oblong-cuneate, narrowly inrolled along margin in lower half. *Stamens* with hyaline, obovate filaments, sparsely hairy on shoulders, anthers ciliate, overlapping filaments at base. *Capsule* 7 mm long, glandular and sometimes also stellate-pubescent on surface, setose along sutures; horns spreading to recurved, pilose, about 8 mm long.

Found on rocky hills and slopes, on quartzite outcrops, sandy shale cliffs, or in gravelly soils. Recorded from the northern Cape (Griqualand West) from Prieska and Kenhardt northwards into Botswana and South West Africa.

CAPE.—Barkly West: Danielskuil, *Acocks* 257. Hay: near Griquatown, *Leisner* 891; Lovedale, *Acocks* 17674. Herbert:

Campbell, *Leistner* 919. Kenhardt: between Pofadder and Aggeneys, *White* 10741. Kimberley: Witdam, *Acocks* H. 849. Kuruman: Olifantshoek, *Hardy & Bayliss* 1249; Langberg, *Sitwell* 40. Prieska: Buis Vlei, *Acocks & Hafström* 946.

S.W.A.—Bethanien: Inachab, *Dinter* 1077 (Z). Gibeon: north of Mariental, *Merxmüller & Giess* 764. Keetmanshoop: Aroab, *De Winter* 3360. Lüderitz: Aus, *Dinter* s.n. (Z); *Dinter* 6040; west of Aus, *Giess & Van Vuuren* 746. Rehoboth: south of Rehoboth, *Hall* 991. Warmbad: Klein Karas, *Dinter* 4856 (Z); Great Karas, *Pearson* 7908. Windhoek: Awas Mts, *Strey* 2568; 2433; west of Windhoek, *De Winter* 2609.

Characterized by the usually stellate-tomentose leaves, the indurating branchlets, and the long, pilose horns on the capsules. *H. affinis*, as defined here, varies considerably, but it can, nevertheless, be recognised as an entity and distinguished from related species. The two species with which it has been very generally confused are *H. spinosa* and *H. helianthemum*. From *H. spinosa* it can be distinguished, among other details, by the branchlets being stellate-tomentose and becoming indurated or spine-like, whereas in *H. spinosa* the branchlets are sparsely stellate-pubescent or glabrous and it is usually the persistent, enlarged peduncles which become spike-like. *H. helianthemum* differs considerably from *H. affinis*, for it has long, slender branchlets which do not become indurated but terminate in raceme-like inflorescences.

In F.S.W.A. *H. complicata* Engl. is placed in synonymy under *H. affinis*, a species to which it is certainly very close, and from which it differs mainly in habit and habitat, being a low, bushy plant confined to the edge of the Namib.

The following insufficiently known species may also be synonymous with *H. affinis*: *H. arenicola* Engl.; *H. longicornuta* Engl. and the unpublished *H. schumannii* Schinz based on *Dinter* 4856 (Z!; PRE, photo.!).

27. *Hermannia fruticulosa* K. Schum. in Verh. bot. Ver. Prov. Brandenb. 30: 233 (1888); in Engl., Monogr. Afr. Pfl. 5: 81 (1900); M. Friedrich et al. in F.S.W.A. 84: 14 (1969). Syntypes: South West Africa, Bethanien, *Schenck*, 361 (PRE!; Z!); Guldbrandtsthal, *Schinz* s.n. (Z!); Schakatsfluss, *Schinz* 602 (K; PRE, photo.!). Z!; BOL!).

Suffrutex, virgate, 40–60 cm tall, stems with grey or brown bark, branches becoming woody and leafless, often glutinous, with numerous minute papillae, otherwise glabrous, ultimate flowering branchlets short and congested with leaves and flowers, minutely papillose. *Stipules* terete, blunt, usually just under 1 mm long, papillose. *Leaves* shortly petiolate; blade oblong-cuneate, 5–10 mm long, 3–8 mm broad, broadest at or near apex, dentate in upper part, teeth usually thickened with glands, upper and lower surface papillate and sparsely stellate-pubescent (hairs appressed), nerves prominent beneath; petiole 1–3 mm long. *Inflorescence* of 1-flowered, solitary cymes, usually in axils of leaves on short congested shoots; peduncle usually very short, about 1.5 mm long (rarely on same plant one up to 2.5 mm long), glabrous; pedicels up to 5 mm long, papillose and sparsely stellate-pubescent, thickening towards apex; bracts minute, ± 0.5 mm. *Calyx* usually lobed to beyond the middle, 4–6 mm long, obscurely papillose with a few appressed stellate hairs without, ciliate on margin and pubescent on inner face. *Petals* broadly oblong-cuneate, about 8 mm long, 4 mm broad near apex, claw with narrowly inrolled margin, not thickened, appearing glabrous. *Stamens* with obtrul- late, hyaline filaments (appearing glabrous), about 3

mm long; anthers 3, ciliate. *Ovary* densely hispid, stipitate (stipe ± 1.25 mm), about 1.5 mm long; styles about 4 mm long. *Capsule* from about 4–5 mm long, with 5 laterally compressed carpels, 2.5 mm broad, papillate on surfaces, sometimes stellate-pubescent too, setose along sutures, with 10 diverging, pilose horns which are up to 8 mm long.

Broken veld, on shaly, quartz or granite hills and plateaux or frequently in water-courses. Recorded from the Gordonias District in the Cape, near the South West Africa border and in the Keetmanshoop, Gibeon and Bethanien Districts of South West Africa.

CAPE.—Gordonias: Rietfontein, *Werdermann & Oberdieck* 2253.

S.W.A.—Bethanien: Aus, *Walter* 2616 (WIND); Helmeringhausen, *Dinter* 8028; Bersaba—Bethanien, *Schenk* 361; Dasiessfontein—Inachab, *Pearson* 7905. Gibeon: Mariental, *Basson* 151. Keetmanshoop: Keetmanshoop, *Acocks* 15619A; Hoachabeb, *Pearson* 7905 (BOL).

Distinguishing features are: abbreviated, slender, congested shoots bearing small, persistent bracts in lower half, and leaves and flowers above; long, indurated branchlets, minutely papillose (not stellate-pubescent) becoming glutinose; peduncle short, persistent; pedicels longer and stellate-pubescent; petals longer than calyx, margins inrolled on claw, not thickened, glabrous on inner face; capsule with five laterally compressed carpels free to the axis; horns 10, long, pilose, spreading and recurved.

28. *Hermannia spinosa* E. Mey. ex Harv. in F.C. 1: 205 (1860); K. Schum. in Engl., Monogr. Afr. Pfl. 5: 80 (1900), but with authors as “(Burch.) E. Mey.”; M. Friedrich et al. in F.S.W.A. 84: 21 (1969). Syntypes: Cape, Gamke River, *Burke & Zeyher* s.n.; Nieuweveld, *Drège* s.n. (K; PRE!).

Mahernia spinosa Burch. ex DC., Prodr. 1: 497 (1824). Type: Cape, Dwaal River, *Burchell* s.n. (K, holo.; PRE, photo.!).

Hermannia asbestina Schltr. in J. Bot., Lond. 36: 373 (1895). Type: Asbestos Mtn, *Marloth* 2057 (PRE!).

H. aspericaulis Dinter & Engl. in Bot. Jb. 55: 366 (1919). Type: South West Africa, Quartel, Rehoboth, *Dinter* 2163 (SAM).

Suffrutex, 20–40 cm tall, usually a rounded bush, with wiry stems and branches, young branchlets sparsely stellate-pubescent with short hairs, glabrescent, usually metallic coloured and flexuose, armed with persistent indurated spine-like peduncles. *Stipules* 1–2.5 mm long, rather thick and sometimes hooked, stellate-pubescent and with gland-tipped hairs, usually a few pointed hairs at apex, persistent. *Leaves* petio- late; blade oblong-cuneate to narrowly so, coarsely toothed in upper half or at broad apex only, or elliptic and entire (both shapes often on the same plant), 4–20 mm long, 2.5–7 mm broad, minutely papillate and stellate-pubescent on both surfaces, usually sparsely so, hairs short from a central scale, radiating and appressed to surface of the leaf; petiole 2–5 mm long, sparsely stellate-pubescent and with a few additional glandular hairs or papillae. *Inflorescence* of 1-flowered, axillary cymes; peduncles at first short, about 2–4 mm long, persistent, glabrescent, becoming indurated and elongating to about 8 mm, rarely longer, more or less patently spreading, appearing spiny but apex blunt; pedicels about 2–5 mm long, nodding, stellate-pubescent, deciduous. *Calyx* from about 5 mm to 7 mm long, lobed to just beyond middle, minutely glandular and laxly stellate-pubescent outside, lobes sparsely appressed hairy on inner face. *Petals* “wine- red”, “purple-mauve”, “rose-red”, “rose-pink”,

"brick-red", oblong-cuneate, 7–10 mm long, margin inrolled on claw only, apparently glabrous on inner face (or reddish papillae in a patch). *Stamens* with narrowly obovate, hyaline filaments, joined at base, free portion 2–3.5 mm long, pubescent on shoulders which are only slightly wider than the overlapping anther bases; anthers 4–5 mm long, ciliate. *Ovary* stipitate, 2.5–3.5 mm long, crowned by 10 erect, 1.5 mm long horns, glandular but with setae along sutures and on horns; styles filiform, erect, cohering. *Capsule* up to 1 cm long, papillose between sutures, stellate with long hairs or setose on sutures; horns ultimately divergent and recurved, up to 8 mm long, pilose; seeds about 7 developed in each cell. Figs 2.2 & 2.6.

Found in karroid veld and on stony koppies in the western Cape from Prince Albert northwards to Gordonia and from Warmbad northwards to Rehoboth in South West Africa.

CAPE.—Beaufort West: Wagonwheel Motel, *Mauve* 4458; east of Beaufort West, *Adamson* D. 166; S.E. of Fraserburg, *Hutchinson* 967. Calvinia: Loeriesfontein, *Lock* 3966. Carnarvon: *Acocks* 1744. Ceres: Gembokfontein, *Hanekom* 2165. Gordonia: N. of Uppington, *Pole Evans* 2137; S.E. of Augrabies, *Leistner* & *Joynt* 2854. Hay: Asbestos Mountains, *Marloth* 2057. Hopetown: Strydenburg, *Acocks* 1700. Kenhardt: Kenhardt, *Leistner* 2331; N.E. of Pofadder, *Van der Schijff* 5710. Prince Albert: Prince Albert, *H. Bolus* 11449; *Marloth* 4412; Gamka River, *Zeyher* 124 (S). Victoria West: Melton Wood Estate, *Smith* 2439. Williston: Williston, *Comins* 684.

O.F.S.—Cult. Fauresmith, originally from Britstown, *Verdoorn* 1110; *Henrici* 2666.

S.W.A.—Bethanien: Helmeringhausen, *Giess* 8805. Gibeon: Gamkanas, *Dinter* 1991 (SAM). Keetmanshoop: W. of Aroab, *De Winter* 3387; E. of Koës, *Leistner* 1798. Maltahöhe: Nassab, *Giess, Volk & Bleissner* 5194. Rehoboth: Quartel. *Dinter* 2163 (SAM). Warmbad: Udabis, *Giess, Volk & Bleissner* 708a; Ariamsvlei, *Schweickerd* 12581.

Distinguished by its habit: a rounded bush habit with many wiry branchlets and straight, persistent, spine-like peduncles.

When Harvey described *H. spinosa*, he stated that he was not sure that *M. spinosa* Burch. was the same species, therefore his name is not a new combination but a new name.

29. *Hermannia linifolia* *Burm. f.*, Prodr. Fl. Cap. 18 (1768); L., Mant. Alt. 256 (1771); DC., Prodr. 1: 495 (1824), as *H. linifolia* L. Type: Cape of Good Hope, specimen in herb. *Burm. f.* (G, holo.; PRE, photo.!; Neg. 5185).

Mahernia scoparia *Eckl. & Zeyh.*, Enum. 51, No. 404. (1834). Type: Cape, "Riedvalley", *Ecklon & Zeyher* Enum. No. 404 (K; PRE, photo.!; TCD; PRE; BOL!)—var. *glabra* *Eckl. & Zeyh.* l.c. Type: Cape, Zwartland near Piketberg, *Ecklon & Zeyher* s.n. (K; PRE, photo.!; TCD;).

Hermannia scoparia (*Eckl. & Zeyh.*) *Harv.*, F.C. 1: 194 (1860); *Adamson* in *Adamson & Salter*, Fl. Cap. Penins. 585 (1950).

Suffrutex, stems several from the taproot, slender, decumbent, with ascending, second branches, stem and branches terminating in an inflorescence, bright green, striate in dried specimens, glabrous or very sparsely stellate-hairy with rays few, long and pointed; internodes 8–40 mm long, sometimes longer. *Stipules* leaf-like, about half as long as leaves, 4–12 mm long, linear, usually broad at base, often sparsely ciliate like the leaves, with distinct, pointed hairs. *Leaves* subsessile, appearing linear but, tapering into a petiole-like base, often acicular, 13–30 mm long, apex acute or broad and lobed, margins often sparsely ciliate with long, pointed, bulbous-based hairs. *Inflorescence* of 1-flowered cymes arranged in terminal racemose cymes. *Calyx* about 6 mm long, lobed to about midway, sparsely stellate-hairy especially on margins and veins, rays long and pointed, few or solitary from a

bulbous base, glabrescent; lobes deltoid with acute to acuminate apex. *Petals* yellow or "orange-yellow", glabrous, about 9 mm long, upper third or half oblong-orbicular, narrowed below into a claw with infolded margins. *Stamens* about 6 mm long; filaments hyaline, oblong, somewhat cuneate, with hairs on shoulders, united around short stipe; anthers about 3.5 mm long, overlapping the filament for 1 mm, ciliate, cells acute. *Ovary* 2.5 mm long, 5-lobed, narrowing towards base, stellate-hairy in upper half, especially along sutures; stipe 1 mm long; styles 5 mm long, cohering, hairy in basal third. *Capsule* more or less globose, bluntly 5-umbonate at apex and with a 1.5 mm long stipe.

Recorded from the Peninsula and northwards from the Malmesbury and Piketberg Districts in the Cape. Found in coastal Fynbos on sandy flats and dunes.

CAPE.—Bellville: Tigerberg, *Pillans* 8619 (BOL). Malmesbury: near Saldanha Bay, *Drège* s.n.; Zwartland, *Ecklon & Zeyher* Enum. No. 404b. Peninsula: Peninsula, *Pappe* s.n. in Herb. Austr. Afr. 14406 (SAM); Rapenberg, *Pillans* 3950; Rietvlei near Milnerton, *Adamson* 2657 (BOL); "Rietvlei", *Ecklon & Zeyher* s.n.; "Riedvalley", *Ecklon & Zeyher* Enum. No. 404. Piketberg: west of Aurora, *Acocks* 19806.

When investigating *H. linifolia* in the sense of Harvey in *Flora Capensis* (1: 195, 1860), it was found that the description and specimens cited did not agree with the type of the species but rather with a variety of *H. filifolia*. *Burman's* type of the species agreed instead with that of *H. scoparia* (*Eckl. & Zeyh.*) *Harv.* based on *Mahernia scoparia* *Eckl. & Zeyh.* Further study of the species shows that *M. scoparia* var. *glabra* *Eckl. & Zeyh.* is merely a glabrescent form of the species and is hardly worthy of any taxonomic rank.

H. linifolia *Burm. f.* is characterized by the very sparse, few-rayed, stellate hairs on the branches and the long-pointed hairs on the margins of the leaves and the calyx, which arise singly or in tufts from a bulbous base. It is a bright green, low, slender-stemmed, procumbent plant with more or less linear leaves and leaf-like stipules which are almost as long as the leaves.

30. *Hermannia decumbens* *Willd. ex Spreng.*, Neue Entdeck. 1: 299 (1880); *Link*, Enum. 2: 181 (1822); *Reichb. Ic. Descr. Pl. Cult.*, t. 52, fig. 1 (1822); DC., Prodr., 1: 494 (1824); *Eckl. & Zeyh.*, Enum. 41: No. 328 (1834); *Harv.* in F.C. 1: 185 (1860); *Adamson* in *Adamson & Salter*, Fl. Cap. Penins. 583 (1950). Type: Cult. Hort. Berlin, *Willdenow* 12327 (B, holo., PRE, photo.!; C;).

H. pratensis *Eckl. & Zeyh.*, Enum. 41, No. 327 (1834). Type: Cape, Caledon, near mouth of "Klynrivier", *Ecklon & Zeyher* Enum. No. 327 (S; PRE, photo.!; SAM!; PRE!).

H. disermifolia sensu *Eckl. & Zeyh.*, Enum. 41, No. 325 (1834), based on specimen from between "Brederivier and Duivenshoeksrivier" (S; PRE, photo.), non Jacq.

H. collina *Eckl. & Zeyh.*, Enum. 41, No. 326. Type: Cape, near "Langehoogde and Pot and Klynrivier", *Ecklon & Zeyher* Enum. No. 326 (S; PRE, photo.).

H. argyrata *Presl*, Bot. Bemerk. 20 (1844). Type: Cape, between Cape Agulhas and Potberg, *Drège* 7303 (K; PRE, photo.!; PRE!; W!).

H. decumbens var. *hispida* *Harv.* in F.C. 1: 185 (1860). Type as for *H. decumbens* *Willd.*—var. *argyrata* (*Presl*) *Harv.*, l.c. Type not indicated.—var. *collina* (*Eckl. & Zeyh.*) *Harv.* l.c. (1860). Type not indicated.

Suffrutex, decumbent; branches up to about 30 cm long, trailing, with inflorescence ascending, with small, scattered, stellate scales, hairs in parts long and matted, sometimes scales stalked. *Stipules* narrowly lanceolate-elliptic to broadly ovate, narrowed or subcordate at base, acuminate and acute to subacute at apex, stellate-pubescent with short or

long, matted, often grey hairs, glabrescent at least on surfaces, several-veined from base. *Leaves* petiolate, variable, blade from narrowly lanceolate-elliptic to ovate-oblong or very broadly ovate-oblong, 9–50 mm long, 5–25 mm broad, evenly or unevenly crenate on margin, sometimes entire, stellate-pubescent with short, or long and matted hairs, often glabrescent at least on surfaces; petiole 4–15 mm long, stellate-pubescent with hairs short or long and matted, sometimes glabrescent in parts. *Inflorescence* terminal in pseudocymose racemes or panicles on ultimate branchlets, flowers clustered in a few, short cymes at intervals along the ascending branchlets, especially towards the ends; bracts variable, mostly stipule-like, from narrowly oblong-elliptic to broadly ovate with subcordate base, up to 9×6 mm long, sometimes the broad bracts 1–2-lobed at apex, usually glabrescent on surfaces; bracteoles usually 3, smaller than bracts, linear to lanceolate-elliptic, often about 3,5×1 mm, rarely up to 10×3 mm and the linear ones 8×1 mm; peduncles usually short, about 5 mm long, rarely longer; pedicels 1,5–5 mm long. *Calyx* campanulate, subinflated, 6–8 mm long, lobed to almost halfway, the stellate or grouped hairs usually long and matted. *Petals* strongly twisted, yellow to orange, oblong-orbicular in upper half, abruptly narrowed into a claw with broad infolded margins, stellate-pubescent on edges of claw and on inrolled margins. *Stamens* about 6–8 mm long; filaments hyaline, obovate-oblong, minutely stellate-pubescent on shoulders. *Ovary* about 3,5 mm long, 5-angled or winged, stellate-pubescent especially on the angles; stipe 0,5 mm long. *Capsule* enclosed in persistent calyx and petals, 5-angled, stellate-pubescent.

Found principally in Coastal Fynbos, in dune bush, on undulating hills and in river plains, in sand or on shaly ground. Recorded from the Cape, from the Peninsula and northwards to Mamre Road and from the Caledon District eastwards along the coast to Knysna, with a few records in valleys farther inland.

CAPE.—Bredasdorp: Between Cape Agulhas and Potberg, Drège 7303; near Wydgeleë, between Malgas and Bredasdorp, Ellis & Schlieben 12398. Caledon: near the mouth of the Klein River, Ecklon & Zeyher Enum. No. 327; 9 km W. of Rietpoel, Acocks 22579. George: Groene Valley, Burchell 3679 (LE). Knysna: Lake Pleasant Hotel, Acocks 21527. Malmesbury: Mamre Road, Compton 18147 (NBG; BOL). Montagu: Kloof at Montagu Baths, Page 27. Mossel Bay: Mossel Bay, Marloth 7540; 17 km N. of Mossel Bay, Acocks 15392. Peninsula: Cape Flats, H. Bolus 2999 (BOL); Salter 7469 (BOL). Riversdale: The Fisheries, Acocks 21344; 14 km S. of Albertinia, De Winter & Verdoorn 9099; Gouritz River, Schlechter 4395.

This species is characterized by the consistently decumbent habit, the practically leafless, ascending inflorescence with clustered flowers, and the hairs on the calyx and parts of the inflorescence which are longer and more obvious than on most other parts of the plant. It is nearest to *H. althaeifolia*, having the same semi-inflated calyx and large stipules, but it can be distinguished by the more or less leafless inflorescence with long, spreading, matted pubescence on the calyx and the usually glabrescent stipules. The areas of distribution are adjacent but do not overlap. *H. althaeifolia* is recorded from the Peninsula and northwards to beyond Calvinia and eastwards to Uniondale and northern Mossel Bay; it is generally found just to the north of the Coastal Fynbos in which *H. decumbens* occurs.

Ecklon & Zeyher 324 (S!; SAM!), the type of *H. diversifolia* Eckl. & Zeyh. (see note under *H. althaeifolia*) seems to be a form or hybrid of this species.

It is cited in F.C. as a synonym of *H. althaeifolia*.

31. *Hermannia prismatocarpa* E. Mey. ex Harv. in F.C. 1: 186 (1860); E. Mey. in Drège, Zwei Pfl. Doc. 103 & 192, nomen (1843); Adamson & Salter, Fl. Cape Penins. 584 (1950); Verdoorn in Flower. Pl. Afr. 41, t. 1628 (1971). Type: Cape, Riebeckskasteel, Drège s.n. (S, lecto., photo.; TCD; LE!).

H. hirsuta sensu Eckl. & Zeyh., Enum. 43, No. 339 (1834), (in S!) non Schrad.

H. rugosa Adamson in Jl S. Afr. Bot. 10: 123 (1944), partly, as to Bolus 12619 (BOL!; PRE!); Pillans 4761 (BOL!; PRE!); Gillett 4162 (BOL!; PRE!).

Suffrutex, branching from base, branches long, decumbent, terminating in leafless, ascending inflorescence, up to 60 cm long, laxly to densely pubescent with minute fringed scales or papillae, interspersed with long, bulbous-based hairs, rarely gland-tipped hairs present; lateral branchlets secund, suberect and terminating in an inflorescence. *Stipules* narrowly to broadly ovate, acute to abruptly acuminate, base usually broad, oblique, rounded or cordate, semi-amplexicaul and sometimes decurrent, 3–10 mm long and about as broad at base, finely stellate-pubescent above and below, sometimes also hirsute with long, pointed hairs. *Leaves* petiolate; blade more or less oblong to ovate-oblong, usually broadest below the middle, slightly cuneate at base, 10–70 mm long, 7–34 mm broad, upper surface finely pubescent with stellate hairs and fringed scales, glabrescent, lower surface thinly and finely white-tomentose (sometimes not obviously white) between nerves, and stellate-pubescent on raised nerves; crenate-dentate and plicate at least when young; petiole 5–20 mm long, densely pubescent either with fringed scales or tufted, pointed hairs, or both. *Inflorescence* of erect, leafless, racemose or paniculate cymes which terminate main branch and branchlets; peduncles and pedicels pubescent as on branchlets; bracts more or less like the stipules, when in groups of 3 the central one elliptic, in upper parts of inflorescence united and lobed, often 3-lobed. *Calyx* shallowly campanulate, finely stellate-pubescent to tomentose without, about 4,5 mm long, 5-lobed almost to middle, sinuses wide, lobes acute. *Petals* twisted, "rich yellow", about 9 mm long, more or less oblong, narrowed at middle and eared, margins half infolded in lower and narrowing to a claw, glabrous or minutely hairy on margin and inner face. *Stamens* with hyaline, obovate-oblong filaments, glabrous or with minute hairs on shoulders; anthers ciliate, overlapping filaments at base. *Ovary* 5-angled and almost flat between the angles, stellate-tomentose with rather short hairs. *Capsule* about 10–16 mm long, with calyx and stamens persisting at base, sharply 5-angled, pubescent with short hairs in tubercle-based tufts, especially on keels of carpels, umbos or horns up to 2 mm long. Figs 2.3 & 2.4.

On hills in the Cape Peninsula and from Tulbagh northwards through Malmesbury to Clanwilliam.

CAPE.—Bellville: near Philadelphia, Mauve & I. Oliver 126. Clanwilliam: near Knechtswlakte, Leipoldt 3671. Malmesbury: Porterville, Schlechter 4501; hills near Saldanha Bay, Hutchinson 276; Kalabaskraal, Hutchinson 195; Moorresberg (sic.), Bolus 9950. Peninsula: 50 km north of Cape Town, Gillett 4162; Tigerberg, Pillans 4761. Piketberg: Brittanania Bay, De Winter & Verdoorn 9071; Schlieben 12433. Tulbagh: Saron, Schlechter 4863; Wellington, Hafström & Acocks 937; Thompson 16.

Characterized by the decumbent habit and the terminal, ascending, leafless, paniculate cymes, the pubescence of minute fringed scales mixed with long, pointed hairs in tubercle-based tufts, the glabrous petals and the long, sharply 5-lobed capsules which are pubescent with short hairs in tubercle-based tufts.

Putative hybrids have been observed between this species and *H. multiflora* and *H. alnifolia*.

What appears to be a form or hybrid of this species was collected south of Vanrhynsdorp near the bridge over Doring River on the way to Clanwilliam (*De Winter & Verdoorn* 9034 & 9035). The plants were somewhat smaller in all parts and the branches, although spreading, were not trailing on the ground. In all other respects they agreed with *H. prismatocarpa*. This needs further investigation.

32. *Hermannia scordifolia* Jacq., Hort. Schoenbr. 1: 64, t. 120 (1797); Reichb., Ic. Descr. Pl. Cult., t. 58, fig. 1 (1923); DC., Prodr. 1: 494 (1824); Harv. in F.C. 1: 187 (1860), partly, excl. syn. Iconotype: Jacq. Hort. Schoenbr. 1, t. 120 (no specimen of actual plant figured can be traced).

H. scordifolia Jacq. var. *integriscula* Harv. l.c. (1860). Syntypes: Cape, Brandenburg, Zeyher 117 (PRE!; Z!; LE!; W!; Cape, Ebenezer, Olifants River, Drège 7289 (7298 sphalm. in F.C.) (W!; S!).

Suffrutex, stems many, somewhat flexible, decumbent, up to 1,5 m long, bright green to glaucous, striate, appearing smooth but often pubescent with stellate or tufted hairs, the hairs short or long, few in a tuft and bulbous-based, branched especially in upper parts; branchlets subherbaceous, secund, ascending, sometimes sparsely stellate-pubescent, glabrescent or with minute gland-tipped hairs, towards the apex. *Stipules* linear to filiform from a broad base, small, about 4 mm long, early caducous. *Leaves* sparse, petiolate; blade discolorous, more or less oblong, from narrowly to broadly so, sometimes ovate-oblong and rarely slightly obovate-oblong, 12–50 mm long, 3–28 mm broad, upper surface subdensely to sparsely and minutely stellate-pubescent, glabrescent, nerves impressed, lower surface whitish stellate-tomentose, sometimes thinly so, nerves prominent, margins shallowly to deeply crenate, sometimes lobate-crenate; petiole 3–20 mm long, stellate-pubescent, densely so in contrast to the subglabrous branches. *Inflorescence* ascending, terminal on branches and branchlets, forming lax panicle or racemous cymes; peduncles 10–60 mm long; bracts united, about 4 mm long, bracteoles filiform or narrowly lanceolate, 1,5–5 mm long, all caducous; pedicels 3–6 mm long, glabrous, stellate-pubescent or with some tufted hairs, sometimes gland-tipped hairs are present. *Calyx* 6–8 mm long, lobed to about midway, finely stellate-pubescent, the rays long or short and with black, gland-tipped hairs intermixed, lobes triangular, sinuses fairly wide. *Petals* yellow, fading orange, 8–10 mm long, upper portion suborbicular, narrowed just above middle into a claw with inrolled margins which are obscurely ciliate. *Stamens* about 7 mm long; filaments hyaline, oblong-cuneate, 4,5 mm long; anthers ciliate, 3,5 mm long, overlapping filaments and base. *Ovary* 2,5 mm long, stellate-pubescent, especially densely at apex where hairs are longer; stipe 1 mm long; styles 4,5 mm long, minutely and sparsely hairy in lower portion. *Capsule* subglobose, exserted from persistent calyx, 5-lobed, shortly 5-umboned, finely stellate-pubescent, more coarsely so on keel of lobes, up to 7 mm long.

Found on coastal dunes, in sandy soil in open veld and on stony outcrops. Recorded from the Cape, from the Malmesbury District through Clanwilliam and Vanrhynsdorp to Calvinia.

CAPE.—Calvinia: Calvinia, *Henrici* 3306; Clanwilliam: Clanwilliam, *Leipoldt* 390; 24 km W. of Clanwilliam, *De Winter & Verdoorn* 9045; Lambert's Bay, *Van Breda* 330; Langevallei, Zeyher 117. Malmesbury: Brittan Bay, *Taylor* 5188; 3 km N.E. of Vredendal, *Hall* 3686; 1,5 km N. of Vredendal, *Thompson* 1007. Vanrhynsdorp: 17 km S. of Vanrhynsdorp, *De Winter & Verdoorn* 9031; Sandkraal, *Acocks* 14801.

H. scordifolia is characterized by the long, smooth-looking, bright green, decumbent branches with terminal, ascending, leafless inflorescences and lateral branches which are ascending and also terminate in an inflorescence. The leaves, on fairly long petioles, vary considerably in shape but are all somewhat discolorous.

H. fistulosa Eckl. & Zeyh., based on *Ecklon & Zeyher* Enum. No. 330 (S; PRE, photo!), appears to be a luxuriant form of *H. scordifolia* and is not here upheld as a separate species. *Bachmann* 2121 (Z!) seems to be intermediate between *Ecklon & Zeyher* Enum. No. 330 and *H. scordifolia*.

33. *Hermannia ternifolia* Presl ex Harv. in F.C. 1: 197 (1860); *H. ternifolia* Presl, Bot. Bemerk. 22 (1844), nomen. Type: Cape, between "Groenkloof and Saldana Bay", *Drège* s.n. (S!; PRE, photo!).

Suffrutex, erect to sprawling, branches slender with small but prominent leaf-bases, densely covered with fringed scales, in parts finely tomentose as well. *Stipules* leafy, narrowly oblong-cuneate, oblanceolate or spatulate, from about 7–12 mm long, 1–2,5 mm broad near apex, on both sides with stellate scales forming a tomentum. *Leaves* shortly petiolate; blade obovate, tapering at base into short petiole, subtruncate or rounded and crenate at apex, from about 7 to 14 mm long and 6–10 mm broad near the apex, stellate-tomentose as on stipules; petiole 1–7 mm long. *Inflorescence* of a few, usually 1-flowered cymes, terminal and in axils of upper leaves, "orange-yellow", "red to orange" or "marmalade-coloured"; peduncles short and stout or up to 5 mm long. *Calyx* about 7 mm long, inflated, oblong to subglobose, somewhat 5-angled, squamulose with minute fringed scales, lobed to about one-third of its length; lobes broadly ovate, mucronulate; sinuses narrow. *Petals* about 13 mm long, strongly convolute, apical portion spreading to recurved; limb oblong-obovate, about 6 mm long, narrowing abruptly into a claw about 7 mm long, scaly-stellate on sides above and with infolded margins for most of length below. *Stamens* with oblong hyaline filaments about 5 mm long; anthers 3 mm long, minutely ciliate. *Ovary* with a very short, 0,5 mm long) stipe, 3,5 mm long, somewhat 5-angled, tomentose with short stellate hairs except at apex where hairs are slightly longer; styles cohering, 5 mm long.

Found in coastal scrub, in sand or on limestone, up to a few miles inland. Recorded from Saldanha Bay and the Peninsula eastwards along the coast to Bredasdorp in the Cape Province.

CAPE.—Bredasdorp: Bredasdorp, *Taylor* 4037; Strand Kloof, *Compton* 14752; Buffelsjacht, *Van Breda* 845. Caledon: Hawston, *Marloth* 9194; Rooi Els, *Leighton* 1456, 2106; Gansbaai, *Gillet* 4268. Malmesbury: between Groenkloof and Saldanha Bay, *Drège* s.n. (PRE, photo!). Peninsula: Pringle Bay, *Boucher* 618; Simonstown Nature Reserve, *Taylor* 5953; Swartklip, *Leighton* 1770.

Characterized by the petioled leaves, the inflated calyx with broadly rounded, shortly acute lobes which are often incurved, and the pubescence of minute fringed scales.

Adamson in Adamson & Salter Fl. Cape Penins., p. 586, mentions that this species cannot be separated from *H. trifoliata* L. With the adequate material now available, these species can be readily distinguished.

34. *Hermannia trifoliata* L., Sp. Pl. 674 (1753); Mant. Alt. 431 (1771); Cav., Diss. t. 182, fig. 1 (1788); DC., Prodr. 1: 494 (1824); Harv. in F.C. 1: 198 (1860); Adamson in Adamson & Salter, Fl. Cape

Penins. 586 (1950). Type: Cape, Cult. Herb. Hort. Cliff. (BM, holo.; PRE, photo.).

H. imbricata Eckl. & Zeyh., Enum. No. 381 (1834). Type: Cape, Paardekop near Plettenberg Bay, Ecklon & Zeyher Enum. No. 381 (S!; PRE, photo.; TCD; PRE!).

Suffrutex, usually under 30 cm tall, often sprawling, stems and branches stellate-tomentose, ridged or quadrate, leafy in upper portion right to apex, stipules and leaves imbricate. *Stipules* oblong, shortly cuneate, stellate-tomentose with fringed crater-like scales, often 2-veined, 5–8 mm long, 2–3 mm broad in upper half. *Leaves* thickly tomentose with fringed crater-like scales, sessile or subsessile, obovate-cuneate, slightly longer than the subtending stipules, 7–10 mm long, 4–5 mm broad at apex, usually folded, apex broadly rounded to truncate, sometimes crenate. *Inflorescence* of cymes in terminal heads, usually nodding and surrounded by stipules and leaves; pedicels 0–2 mm long, with reddish brown fringed scales. *Calyx* about 7 mm long, lobed in upper third, becoming somewhat inflated, covered with small crater-like fringed scales, hairs very short, lobes erect or inflexed, rather broad, mucronate, sinuses fairly narrow. *Petals* "red", "orange" or "claret-red", twisted, with upper portion of the blade spreading to reflexed, about 10 mm long, suborbicular in upper third, narrowed in middle forming a long waist, lower third clawed with infolded margins, ciliate in middle. *Stamens* about 4, 5 mm long, united at base, filaments very thinly hyaline, oblong, slightly narrowing towards base, nerves brown; anthers usually less than 2 mm long, ciliate, overlapping filaments at base. *Ovary* pubescent, 5-lobed, lobes rounded at apex; styles cohering, stigmas terminal. *Capsule* enclosed in the somewhat enlarged calyx, about 5 mm long, 5-angled and 5-umbonate.

Found in Fynbos and Dune Bush and sometimes on limestone ridges or chalk hills near the sea. Recorded along the coast from Bredasdorp to Riversdale.

CAPE.—Bredasdorp: Cape "Between Aghullas & Potberg"; *Drège* s.n.*; Sandhoogte, *Smith* 2997; Bredasdorp, *Sidey* 1807, *Acoks* 15459; Bredasdorp Poort, *Compton* 14727; Riversdale: Vermaaklikheid, *Acoks* 22530; Stille Bay, *Muir* 1969; Milkwoodfontein, *Galpin* 3782; Albertinia, *Muir* 1777.

This species is characterized by the imbricating leaves and stipules which are concentrated in the upper portion of the branches and by the terminal flower heads which are usually nodding and surrounded at the base by the upper leaves and stipules. The calyx becomes rather membranous and subinflated with age.

Cavanille's figure of *H. trifoliata* is on t. 182, fig. 1, not fig. 2, as cited in *Flora Capensis* and in *De Candolle's Prodrômus*.

A specimen of *Ecklon & Zeyher* Enum. No. 381, the type number of *H. imbricata* in PRE has long, exposed pedicels whereas on photos of the same number in S and TCD the pedicels are hidden by the leaves.

35. *Hermannia concinnifolia* Verdoorn in Flower. Pl. Afr. 43, t. 1691 (1974). Type: Cape, Bredasdorp district, De Mond Forestry Reserve, *Taylor* 8248 (PRE, holo.).

Suffrutex, 15–90 cm tall, branching from base; branches ascending, leaves and stipules usually neatly arranged in ranks (imbricate), pubescence not conspicuous, consisting of minute fringed scales or stellate hairs, grouped hairs from a tubercled base also

sometimes present. *Stipules* green, subcoriaceous, 7–10 mm long, about 3 mm broad, more or less oblong or oblong-elliptic, sometimes slightly oblique and slightly narrowed towards base, mucronate or bimucronate. *Leaves* subsessile, lettuce-green, subcoriaceous, broadest at apex narrowing into a petiole-like base, plicate, apex rounded and emarginate with a recurved mucro or more or less truncate with 2 or more lobes, rough with minute, fringed scales and often minute, stellate hairs on margin, margin sometimes with a narrow red-brown rim. *Inflorescence* of 1–2-flowered cymes at apex of leafy branchlets and in axils of upper leaves; peduncle suberect, 5–12 mm long, with stipule-like bracts at base; pedicels cernuous, 2–3 mm long, with 3 narrow, 4–5 mm long bracteoles at base. *Calyx* often suffused or mottled with red, campanulate, rough with minute stellate scales and on margins with a few short hairs from a tubercled base, 6–9 mm long, somewhat 5–10-angled, 5-lobed; lobes about 4 mm long, broadly oblong, shortly acuminate and mucronate, sinuses narrow. *Petals* lemon-yellow, strongly twisted, shortly exerted from calyx, about 10 mm long, blade broadly oblong, contracted below middle into a claw with infolded margins and minute stellate hairs on edges of claw. *Stamens* about 5 mm long; filaments hyaline, oblong; anthers 2, 5 mm long, ciliate. *Ovary* 3–4 mm long, 2, 5–3, 5 mm broad, 5-lobed, stellate-tomentose; stipe 0, 5 mm long; styles 4 mm long. *Capsule* enclosed by persistent calyx and petals, about 6 mm long, 5 mm diam., 5-angled, thinly stellate-tomentose between angles, more coarsely so on angles.

Found in Coastal Fynbos on limestone formations. Recorded from the Bredasdorp, Swellendam and Riversdale Districts in the Cape Province.

CAPE.—Bredasdorp: near Wydgelegen, *Acoks* 23171; *Schlieben & Ellis* 12399; De Hoop Provincial Farm, *Lewis* 6031 (NBG); Windhoek Plato, *C. V. van der Merwe* 1006; near Arniston, *Marsh* 920; De Mond Forestry Reserve, *Taylor* 8248 (type). Riversdale: S. of Vermaaklikheid Post Office, *Acoks* 24124; Hanglip, *Muir* 1961. Swellendam: Cape Infanta, *Walgate* 879.

This recently described species is characterized by the leafy branches with regularly arranged, rather stiff leaves. The stipules are leaf-like and usually more than half as long as the leaves. They can be distinguished from the leaves by their shape which is more or less oblong and not clearly narrowed towards the base. The leaves and stipules, which appear to be glabrous, are minutely stellate-pubescent.

H. concinnifolia has, to date, been found only in Coastal Fynbos on limestone formations in the Bredasdorp district and eastwards to Riversdale. It can be distinguished from the nearly related species *H. rudis* and *H. flammea* principally by the more densely leafy branches with regularly arranged leaves. Compared with *H. rudis* it is also less roughly pubescent and from *H. flammea* it can be distinguished by the flowers being more compactly disposed, not in elongated racemose cymes. In the case of *H. flammea* the petals are usually dark red, at least on the outside, and on herbarium specimens they dry darker than the calyx. This is not usually so in *H. concinnifolia* which has been described as having yellow petals. Colour, however, often varies in most species of *Hermannia* and cannot be relied on as a diagnostic feature.

36. *Hermannia muirii* Pillans in Verdoorn in Bothalia 10: 571 (1972). Type: Cape, Riversdale District, Droogeveldvlakte, *Muir* 1882 (BOL, holo.; PRE!).

* In Zwei pflanzengeographische Documente, p. 122, this *Drège* specimen is numbered 7275, but a specimen in W bearing this number and no name is *H. concinnifolia*. Gatherings in LE and PRE with the same number are *H. trifoliata*.

Shrublet, low, branched from base; branches subsparingly hispid with long, fairly soft hairs, 2 or more grouped on a bulbous base, old wood glabrescent but rough with minute hair-bases. *Stipules* foliaceous, more than half the length of subtending leaf, oblong, narrowly oblong or ovate-lanceolate, usually broad-based, 5–10 mm long, hispid especially on margins. *Leaves* sessile to subsessile, neatly imbricately arranged, more or less oblong, usually narrowing slightly towards base, 6–10 mm long, entire or occasionally few-lobed at apex, hispid as on stipules. *Inflorescence* of 1–2-flowered cymes in axils of crowded upper leaves, appearing to grow in clusters at apices of branches and branchlets; peduncles short, about 1–2 mm long; bracteoles 3, linear, about 4 mm long; pedicels about 4 mm long, hispid as in other parts. *Calyx* about 6 mm long, lobed to just below middle, laxly pubescent with long hairs grouped on a bulbous base, tube cyathiform, lobes deltoid-acute. *Petals* white becoming pale pink, 7–8 mm long, upper portion oblong-obovate, narrowing just below middle into a claw with infolded margins, glabrous. *Stamens* about 4 mm long; filaments oblong-cuneate, hyaline; anthers 2.5 mm long, overlapping hyaline filaments for 0.75 mm. *Ovary* stellate-tomentose, about 4 mm long, 5-lobed, lobes rounded at apex; stipe 1 mm long; styles 4 mm long. *Capsule* more or less enveloped by the calyx and petals, about 4 mm long, subrotund, 5-lobed, stellate-pubescent with short hairs between sutures and longer hairs on sutures.

Found in Coastal Fynbos in sandy valleys between limestone ridges south of Albertinia; locally common. Recorded only from the Riversdale and Uniondale Districts.

CAPE.—Riversdale: Droogeveldvlakte, Muir 1882; Ystervarkfontein, Bayliss 3774; Buffelsfonteinlaagte, Acocks 22890; about 15 km S. of Albertinia, Acocks 24170.

Characterized by the wiry, dark brown branches, the light green, neatly arranged, suberect, usually entire and hispid leaves and stipules, the stipules which are leaf-like and almost as long as the leaves, the white flowers which turn pale pink; the calyx divided to or beyond the middle, drying with brownish borders and having a cyathiform tube.

37. *Hermannia floribunda* Harv. in F.C. 1: 201 (1860); Burt Davy, Fl. Transv. 1: 267 (1926); Wild in FZ. 1: 542 (1960). Type: Transvaal, Vaal River, Jan. 1842, Burke & Zeyher s.n. (K; PRE!).

H. melissifolia Engl. in Bot. Jb. 55: 357. Type: Lesotho, Leribe, Dieterlen 555 (B, holo.†; PRE!; Z!).

Suffrutex, 60–120 cm tall, branched at base, branches long, erect or sprawling, subdensely stellate-pubescent, hairs fairly long from a minute bulbous base, often shortly stalked, older glabrescent parts rough with minute persistent stalks. *Stipules* from ovate to ovate-acuminate, ovate-lanceolate or subulate, 3–7 mm long, 1–4.5 mm broad near base, soon withering and falling on old wood, stellate-pubescent. *Leaves* petiolate; blade ovate, ovate-cordate or ovate-oblong, occasionally broader than long, about 2–6 cm long, 1–7 cm wide near base, usually 5-nerved from base, nerves prominent beneath, stellate-pubescent on both surfaces, hairs fine and appressed, from a central scale, some shortly stalked and caducous, lower surface slightly lighter than upper, margins unevenly crenate; petiole 1–3 cm long, stellate-pubescent. *Inflorescence* of 1– to several-, mostly 3-flowered, cymes simple or crowded in axils of leaves and at apices of main branches and short

lateral branchlets; flowers many, small, under 6 mm long on dried specimens; peduncles about 1–3 mm long, stellate-pubescent; pedicels 2–5 mm long; bracts more or less subulate or lanceolate, 1–3 mm long. *Calyx* broadly campanulate, becoming thin and subinflated, 5.5 mm long, stellate-pubescent with hairs fine and some spreading, lobed to about one third from top, lobes mucronate. *Petals* about 6.5 mm long, narrowly oblong-obovate, with infolded lobes just below middle and narrow infolded margins on claw. *Stamens* about 5 mm long, with narrow, more or less linear, hyaline filaments overlapped by anther bases. *Ovary* about 2.5 mm long, densely stellate-tomentose, 5-lobed; stipe under 1 mm long; styles about 3 mm long. *Capsule* about 6 mm long and broad, exerted from persistent, subinflated calyx, 5-lobed, lobes acute to mucronate, punctate and stellate-pubescent, hairs from a microscopic scale or base, becoming short and wearing off with age.

Found on stony hill slopes, in shade or open grassveld, also on rocky ledges. Recorded from Leribe in Lesotho, the Potchefstroom District in the Transvaal and northwards to the Soutpansberg District. Also occurs in Botswana and Rhodesia.

TRANSVAAL.—Heidelberg: Suikerbosrand, Bredenkamp 442. Johannesburg: Ormonde, Gerstner 6533. Krugersdorp: Witpoortjie, Murray 664. Letaba: Sarahsdrift, Scheepers 943. Lydenburg: Magnet Heights, Barnard & Mogg 858; Erasmus Pass, Codd 10499. Pietersburg: Dyer 3164; Blouberg, Strey & Schlieben 8614. Potchefstroom: Vaal River, Burke & Zeyher s.n.; Rhenosterfontein, Cohen 301. Potgietersrus: Pyramid Estate, Galpin 8925. Pretoria: Leeuwhoeck, Strey & Leistner 8274; Crocodile and Magalies Rivers, Burt Davy 198. Soutpansberg: Louis Trichardt, Rogers 21149 (Z); Gerstner 5785; Tshakoma, Obermeyer 991. Zeerust: Linokana, Holub s.n. (Z).

LESOTHO.—Leribe, Dieterlen 555.

H. floribunda is characterized by the long branches which arise near the base of the plant; these may be erect or sprawling and are stellate-pubescent not canescent-tomentose; they bear short, floriferous lateral branchlets. The specific name is apt, because in the axils of the leaves and at the apices of both the main and lateral branches, several cymes with flowers of different ages are clustered, with several grey, subglobose buds in each group.

From the description of *H. floribunda* Harv. given by K. Schumann in Engl., Monogr. Afr. Pfl. 5: 56 (1900), it is obvious that the specimens he had before him did not belong to this species. In F.S.W.A. 84: 17, Schumann's concept is put into synonymy under *H. minutiflora* Engl. and this is in all probability correct although the two specimens cited have not been seen.

H. minutiflora differs from *H. floribunda* in being a much smaller plant with smaller leaves and flowers and with canescent-tomentose branches.

38. *Hermannia bryoniifolia* Burch., Trav. 2: 258 (1824), as *bryoniaefolia*; DC., Prodr. 1: 494 (1824), as *bryonifolia*; Harv. (under doubtful and little known species) in F.C. 1: 207 (1860); K. Schum. in Engl., Monogr. Afr. Pfl. 5: 56 (1900); Burt Davy, Fl. Transv. 1: 267 (1926), partly, excl. loc. Transvaal. Type: Cape, Postmasburg, Blinkklip, Burchell 2141 (K, holo., PRE, photo.†; PRE!; LE!).

H. rehmannii Szyszyl., Polypet. Thalam. Rehm. 139 (1887). Syntypes: Cape, Roggeveld, Rietpoort, Rehmann 3249 (Z!); Orange Free State, Bloemfontein, Rehmann 3797 (Z!); Rietfontein, Rehmann 3715 (Z!).

Suffrutex, bushily branched, leafy parts ± uniformly covered with rather coarse stellate hairs from a scaly base, on lower parts from a tubercled base, rarely interspersed with obscure, gland-tipped hairs, rays

many but short, mostly under 0,5 mm long. *Stipules* variable, even on same specimen, from narrowly lanceolate to broadly ovate and then sometimes subcordate and semi-amplexicaul at base, sometimes also 3-lobed, from about 2 mm to 5 mm long and 1–4 mm broad. *Leaves* ovate to ovate-oblong, varying in size (even on same branchlet), from 5×3 mm near base to 30×20 mm, distinctly stellate-pubescent on both surfaces, unevenly crenate-dentate on margin (twice crenate or shallowly lobed and crenate); petiole 3–15 mm long, densely and coarsely stellate-pubescent. *Inflorescence* axillary of 1–3-flowered usually 2-flowered cymes on simple, dichotomous, ultimate branchlets, with most of leaves much reduced and so appearing to be racemose or panicle cymes; peduncles varying greatly in length, 2,5–8 mm long, coarsely stellate-pubescent; pedicels similar but much shorter, 1–4 mm long; bracts linear-lanceolate, 2–4 at base of pedicels, stellate-pubescent. *Calyx* usually thin in texture, coarsely stellate-pubescent, 5-lobed to slightly above or slightly below middle. *Petals* yellow, more or less oblong with margins infolded in lower half, apparently glabrous but with a few minute hairs on infolded margins, narrowed at base into a short claw about 1 mm long. *Stamens* about 4 mm long, with hyaline oblong-ovate filaments, joined at base and with a few short hairs on shoulders which are overlapped by anther bases; anthers pointed, ciliate. *Ovary* ±2 mm diam., stellate-pubescent, shallowly 5-lobed, ±sessile; styles 2,5 mm long, sparsely and shortly hairy. *Capsule* about as long or slightly longer than calyx, i.e. 3–4,5 mm, coarsely stellate-pubescent, shallowly 5-lobed, lobes obscurely keeled. *Seeds* reniform with folds or wrinkles and minutely granular.

In loamy ground on hills, among rocks, on rocky ledges in crannies. Recorded from Griqualand West, the Orange Free State, and across the Vaal River in the Potchefstroom District.

CAPE.—Colesberg: Colesberg, *Marloth* 49036. Herbert: near Campbell, *Leistner* 905; Kimberley: Wimbledon, *Badenhorst* 53; Hay: Asbestos Mts, *Marloth* 2026. Barkly West: Windsorton, *Hafström* 918 (S), *Hafström* & *Acocis* H. 918; Postmasburg: Beeshoek, *Leistner* & *Joynt* 2707; Blinkklip, *Burchell* 2141. Gordonias: Upington, between Olifantshoek and Upington, *Schweickerdt* 2524. ?Roggeveld, Rietpoort, *Rehmann* 3249 (Z).

O.F.S.—Bloemfontein: *Rehmann* 3797 (Z); Naval Hill, Moss 4609 (Z). Boshof: Boshof, *Brueckner* 895. Fauresmith: Bergplaats, *Smith* 4378. ?Rietfontein, *Rehmann* 3715 (Z).

TRANSVAAL.—Potchefstroom: Dassiesrand, *Van Wyk* 423.

K. Schumann mistakenly cited the locality for *Rehmann* 3249 as being “Transvaal, Roggeveld, zwischen Porter and Trigardsfontein”. It should be “Roggeveld Rietpoort”, and as the collection has a relatively low number, it must have come from the north-western Cape where the other representatives of this species are found. *Acocis* writes in connection with the *Rehmann* locality “Rietpoort, Roggeveld”: “There is a Rietpoort a few miles east of Lokenburg, just to the south of Augustfontein, which could be regarded as being in the Roggeveld”. Lokenburg is situated about 40 km south of Nieuwoudtville in the Cape.

H. byroniifolia is characterized by the ovate-oblong leaves which are lobulate-crenate and fairly coarsely stellate-pubescent. The flowers and capsules are small.

39. *Hermannia cordifolia* Harv. in F.C. 1: 193 (1860). Type: Cape, Piketberg, “Bonzagen”, *Zeyher* 111 (TCD, hol., PRE, photo.; S!; K!; SAM!).

Suffrutex, robust, erect, up to 1 m high; branches ascending, stout, dark brown, densely stellate-pubes-

cent, the hairs of different lengths, sometimes with gland-tipped hairs intermingled. *Stipules* ovate, acuminate, often oblique, cordate to semi-cordate and decurrent at base, about 12 mm long, 7 mm broad near base. *Leaves* petiolate; blade large, ovate to ovate-oblong, 2–5 cm long, 1,5–3 cm broad, rounded to subcordate at base, crenate-undulate on margins, upper surface hirsute with hairs from a scaly base but lying in one direction, lower surface grey-tomentose and stellate-pubescent, nerves prominent beneath; petiole short, 3–12 mm long, densely stellate-pubescent, the rays of different lengths. *Inflorescence* of compound, axillary cymes; ultimate cymes 2-flowered, congested; peduncles 10–30 mm long; pedicels up to 7 mm long; bracts 25 mm long, 7 mm broad, bracteoles like the stipules but smaller and some subulate. *Calyx* 7,5–9,5 mm long, lobed in upper third, densely stellate without, tube at first suburceolate but wide at mouth when mature with capsule protruding, lobes deltoid, erect. *Petals* 9–10 mm long, upper half oblong-cuneate, narrowing gradually into a claw with inrolled margins. *Stamens* about 6 mm long; filaments hyaline, obovate; anthers overlapping filaments for 1 mm. *Ovary* not seen. *Capsule* 8 or 9 mm long, densely stellate-pubescent, shallowly lobed, lobes rounded at apex.

To date the species is known only from the original gathering, *Zeyher* 111, and the more recent *Pillans* 7992. Both were collected in the Piketberg District.

CAPE.—Piketberg: “Bonzagen” on the Piketberg, *Zeyher* 111; Kapiteins Kloof Mountain, *Pillans* 7992.

The description was drawn up from the few pressed specimens available (*Zeyher* 111 in S and SAM and *Pillans* 7992 in BOL). *H. cordifolia* is nearest *H. rugosa*, but differs in being a more robust, erect plant with larger leaves, calyces and capsules, and in having a clustered inflorescence and a calyx which is suburceolate to campanulate, not somewhat salver-shaped as in *H. rugosa*.

40. *Hermannia hispidula* Reichb., Ic. Descr. Pl. Cult., t. 69 (1823); Walp., Repert. 1: 346 (1842); Harv. in F.C. 1: 207 under “little known species” (1860). Iconotype: Cape, cult. Dresden, t. 69 in Reichb. l.c. (typotype not traced).

Suffrutex with several ascending branches from a thick tap-root, branches hispid with long, pointed hairs, one to several from a prominent base, sometimes interspersed with short gland-tipped hairs. *Stipules* 2–6 mm long, oblique, broad-based and decurrent, abruptly narrowed into an acumen up to 4 mm long, basal portion 1–3 mm broad, sparsely hispid with bulbous-based or stellate hairs. *Leaves* petiolate; blade narrowly to broadly ovate or suborbicular, mucronate, base broadly cuneate, dentate, upper surface and margin sparsely hispid with bulbous-based hairs, lower surface finely and densely stellate between the nerves, more coarsely so on nerves; petiole 2–8 mm long, hispid. *Inflorescence* terminal on branchlets, a lax racemose cyme, hispid as on branchlets and sometimes with gland-tipped hairs interspersed, bracts 3–5, like stipules but those at base of pedicels much reduced; peduncles 8–30 mm long; pedicels 2–6 mm long. *Calyx* about 5 mm long, more or less cup-shaped, 5 lobed almost to middle, sinuses wide, very sparsely hispid with one or more hairs from a bulbous base. *Petals* yellow, about 8 mm long, upper portion oblong-orbicular, narrowed just below middle into a claw with broadly infolded margins. *Stamens* about 5 mm long with oblong-cuneate halane filaments; stamens acute, ciliate, about 2,5 mm long.

Ovary about 2,5 mm long, stellate-hairy, hairs long at apex, 5-umbonate, 5-angled; stipe 0,75 mm; styles 3,5 mm. *Capsule* about 6 mm long, glabrescent or very sparsely hispid with grouped hairs, 5-angled, 5-umbonate, calyx and stamens persistent and sometimes petals too.

Found on mountain slopes, at the foot of sandstone ridges in humus-rich pockets of sandy soil. Recorded from the Piketberg District in the western Cape.

CAPE.—Piketberg: Piketberg, *Maguire* 1182 (NBG); Piketberg mountain, *Compton* 22114 (NBG); near Piketberg, *De Winter & Verdoorn* 9059; *Bolus* 7538 (BOL); near Goedverwacht, *Bolus* 8416 (BOL).

There can be little doubt that this species is represented by Reichenbach's figure and his notes confirm this. Distinguishing features are the acute, dentate leaves, green and roughly pubescent on both sides and the obvious hispid hairs on all parts of the plant. The oblique broadbased stipule is a feature shared with several other species such as *H. prismatocarpa* and *H. repetenda*.

41. *Hermannia rugosa* Adamson in Jl S. Afr. Bot. 10: 123 (1944); Verdoorn in *Boutan* 11: 519 (1975); Adamson in Adamson & Salter, Fl. Cape Penins. 584 (1950), partly. Type: Cape, Newlands, *Salter* 8772 (BOL, lower specimen on sheet, lecto.!).

Shrublet, rigid, spreading-erect, radical, 30–60 cm tall; branches rough with tubercle-based hairs. *Stipules* narrowly to broadly ovate, acuminate to abruptly acuminate, rounded or cordate to semi-cordate and decurrent at base. *Leaves* petiolate; blade varying in shape and size, narrowly to broadly ovate to obovate, rounded or broadly cuneate to cuneate at base, crenate and crisped on margins, minutely densely stellate on both surfaces, sometimes whitish tomentose on lower surface, nerves prominent beneath; petiole about 3–7 mm long. *Inflorescence* of racemose cymes, cymes 1 or more at a node, 1–3-flowered, the terminal with flowers appearing clustered, branches of inflorescence stellate-pubescent with hairs short from a scaly base or longer from a tubercled base, gland-tipped hairs sometimes present; bracts like stipules; bracteoles deltoid to subulate. *Calyx* somewhat salver-shaped, 5,5 mm long, 5-angled in upper half, lobed to almost midway, sinuses wide, densely stellate-pubescent, the hairs long from a small reddish brown, tubercular base mixed with short hairs from a centr. l scale. *Petals* "golden yellow", "orange-red" or "yellow and red", 9–12 mm long, twisted, oblong to suborbicular in upper half narrowing to a claw with infolded margins. *Stamens* about 6 mm long with hyaline, obovate filaments. *Ovary* about 2,5 mm long, 5-lobed; stipe 0,75 mm long; styles about 5 mm long. *Capsule* enclosed by persistent perianth, densely stellate-pubescent.

Only a few records of this species have been seen. They come from the Peninsula and from the Paarlberg and vicinity.

CAPE.—Bellville: Tygerberg Reserve, *Loubser* 3367. Paarl: Between Paarlberg and Paardeberg, *Drège* (S; SAM); Paarl Mountain, *Kruger* M 22; *Thompson* 1756. Peninsula: Newlands Estate, *Salter* 8772, partly (BOL); *Salter* 8669; 8780 (BOL); 8900 (NBG); S.W. of Durbanville, *Esterhuysen* 17570 (BOL).

The species is characterized by the leaves being crisped as well as crenate on the margin, the calyx being somewhat salver-shaped and with a thick tomentum as in *H. multiflora* but with longer, softer hairs intermixed.

Compton 20752 (NBG) from Bellville is nearest *H. rugosa*.

There is evidence that *H. rugosa* may hybridize with *H. multiflora*. The following paratypes are excluded: *Adamson* 2511, which is probably a hybrid, *Pillans* 4761 (cited as 4701), *Gillett* 4162 and *H. Bolus* 12619, all three of which are *H. prismatocarpa* E. Mey. ex Harv.; *Gillett* 3731 which is probably *H. repetenda* Verdoorn, and *H. Bolus* 9948, a putative hybrid nearest *H. scabra* Cav.

42. *Hermannia althaeoides* Link, Enum. Hort. Berol. 2: 179 (1822); Eckl. & Zeyh., Enum. 42, No. 334 (1834). Type: Cape, cult. Europe (B†, holo.); Uitenhage, Coega River near "Zwartkopshoogte", *Ecklon & Zeyher* Enum. No. 334 (S, neo!; PRE, photo.!; TCD, photo.!; PRE!; LEI; NBG!).

H. nemorosa Eckl. & Zeyh., Enum. 42, 335 (1834). Type: Cape, Uitenhage, between the Sunday's and Bushman's Rivers, *Ecklon & Zeyher* Enum. No. 335 (K, PRE, photo.!; NBG!).

H. plicata sensu Eckl. & Zeyh., Enum. No. 341 (S; PRE, photo.!; NBG!) (1834), non Ait.;

H. mollis sensu Eckl. & Zeyh., Enum. No. 336 (K; PRE, photo.!; PRE!; Z!) (1834), non Willd.;

H. discolor Otto & Dietr., Gart. 8: 314 (1840). Syntypes: cult. Europe (not traced); Uitenhage, "Zwartkopsvier", *Ecklon & Zeyher* Enum. No. 337 (S; PRE, photo.!; PRE! NBG!) named "var. *discolor*" in S and listed as No. 327 (sphalm.) by Harv. in F.C. 1: 186 (1860) under *H. candicans* var. *discolor* Harv.

H. candicans sensu Harv., l.c. (1860), pro parte majore, non Ait.

Suffrutex, erect or suberect and widely branching at base; branches ascending, up to 60 cm tall; pubescence on branchlets, inflorescence and leaves varying from densely and smoothly to roughly and thinly tomentose, often with numerous minute gland-tipped hairs interspersed, or glabrescent with scattered rough stellate or tufted hairs. *Stipules* small (not leaf-like), subulate to deltoid-acuminate, 3–8 mm long, base 1–2,5 mm broad, rounded but not cordate, stellate-pubescent to stellate-tomentose. *Leaves* petiolate; blade variable in size and pubescence, ovate-oblong or broadly, rarely narrowly, oblong, occasionally suborbicular, 10–50 mm long, 6–30 mm broad, base broadly cuneate to rounded or somewhat cordate, apex rounded or rarely broadly acuminate and acute, margins faintly to distinctly crenate to base or almost so; pubescence varying from finely to softly stellate-tomentose on both surfaces to discolourous with upper surface roughly stellate-pubescent and lower surface softly whitish tomentose. *Inflorescence* of 1 or several, 1- to several-flowered cymes in axils of upper leaves and often forming terminal, leafless, paniculate cymes; branches of inflorescence from densely tomentose to glabrescent with scattered stellate or tufted hairs, but often (on inland specimens) with numerous, minute, gland-tipped hairs interspersed. *Calyx* campanulate, about 3–7 mm long, texture thin, from thinly to densely stellate-pubescent or tomentose outside, with a few hairs on inside near margin, lobed in upper third or almost to half way, lobes deltoid, sinuses wide. *Petals* yellow turning red at maturity, not long persistent, 7–11 mm long, upper third suborbicular, 5–6 mm diam., "waist" 1,5–2 mm broad, lower portion with infolded margins, glabrous or obscurely ciliate and pubescent within, not tomentose along edges of claw. *Stamens* about 5 mm long, with broad, hyaline, obovate filaments ciliate on shoulder; anthers overlapping the filaments at base, ciliate. *Ovary* 4 mm long, 5-angled, stellate-pubescent, 5-umbonate at apex, shortly stipitate at base, styles adhering. *Capsule* usually exposed, up to 8 mm long, about as long as petals.

Found on rocky slopes, in hillside scrub, grassy valleys, sandy soil along rivers, coastal thornveld and dune veld. Recorded only from the Cape from the coastal area of Humansdorp eastwards to Bathurst and northwards through Somerset East to Middelburg and then south eastwards through King William's Town to Komga.

CAPE.—Albany: Bushman's River, *Story* 2349; Grahamstown, *Galpin* 144; Coombes Valley, *Bayliss* 4352; Botha's Hill, *Dyer* 1451. Alexandria: near Nanaga, *Acocks* 12800; Quagga Flats, *Burt Davy* 11930; Bushman's River Mouth, *Lanham* 132; *Galpin* 10673. Bathurst: Bathurst, *Sidey* 3139; *Hutchinson* 1557; Port Alfred, *Galpin* 2951; *Schlechter* 2686; Kowie, *Britten* 680; 672; 2591. Fort Beaufort: Koonap Heights, *Britten* 2031. Humansdorp: Kabeljouw, *Phillips* 3325; Klipdrift, *Thode* A2464. Keiskammahoek: Keiskammahoek, *Wells* 3103; *Acocks* 0123. King William's Town: King William's Town, *Tyson* 850. Komga: Komga, *Flanagan* 487. Middelburg: Gordonville, *Acocks* 17999. Port Elizabeth: Port Elizabeth, *Sidey* 3047. Queenstown: Junction Farm, *Galpin* 8255. Somerset East: Klein Bruintjieshoogte, *Drège* 7297d. Uitenhage: Uitenhage, *Thode* A630; near Zwartkops River, *Ecklon & Zeyher* Enum. No. 336; near Uitenhage, *Ecklon & Zeyher* 1982; 1983 (W); *Marais* 146; *Schlechter* 2507; Addo, *Ecklon & Zeyher* Enum. 334; 337.

The pubescence varies considerably in this species, from densely and smoothly to roughly and thinly tomentose. *Ecklon & Zeyher* Enum. No. 334 in S was chosen as neotype because it has the ferrugineous pubescence mentioned in the original description.

This variable species is distinguished from *H. incana* mainly by the inflorescence which ends in a leafless, racemose or paniculate cyme, by smaller flowers with petals that fall, leaving the maturing capsule partly exposed, and by the tomentum not being as uniform as that of *H. incana*. Moreover, *H. althaeoides* is not as tall or robust a shrublet as *H. incana*.

Remarking on his four varieties of *H. candicans* Ait., which mainly constitute the species here described, Harvey writes in F.C. 1: 186 "Very variable in size and pubescence, but tolerably constant in other characters. I have no hesitation in uniting under one head, the various specimens of Ecklon & Zeyher above quoted." On examination of representatives of Ecklon and Zeyher specimens listed the same conclusion has been reached with the exception of *Ecklon & Zeyher* Enum. No. 333 which is *H. incana*, the earlier name for *H. candicans*.

The specimens of *Schlechter* 6103 in Z and BOL, the type number of *H. prismatocarpoides* Engl., fall within the variation of *H. althaeoides* Link, and that species is therefore probably also a synonym of our species. Note that the Botha's Hill, at which *Schlechter* 6103 was collected, is the one near Grahamstown, not that near Durban.

43. *Hermannia minutiflora* Engl. in Bot. Jb. 55: 361 (1919); M. Friedrich et al. in F.S.W.A. 84: 17 (1969). Type: Cape, Namaqualand, l'us *Schlechter* 11426 (PRE, lecto.!; W!; LE!; MO!; BOL!; Z!).

H. floribunda sensu Schum. in Engl., Monogr. Afr. Pfl. 5: 56 (1900), non Harv.

Suffrutex, erect, bushy, 20–60 cm tall, much branched, in all parts canescent with two layers of stellate hairs, rays many from a central scale, spreading or in upper layer tufted on scales which often become detached, very minute black-headed glandular hairs often scattered in the tomentum, branches and branchlets somewhat zigzag. *Stipules* varying in size, 1.5–4 mm long, 0.5–1.5 mm broad. *Leaves* petiolate; blade suborbicular or broadly ovate-oblong, 4–19 mm long, 4–20 mm broad, truncate or

broadly cuneate at base, sometimes some of upper leaves cuneate in lower third, obscurely 3–5-lobate, margin crenate, plicate or corrugated at least towards margin; petiole 2–10 mm long. *Inflorescence* of 1 or more 1–3-flowered cymes in axils of upper leaves and terminal on ultimate branchlets often forming leafy, cymose racemes, flowers on herbarium specimens under 5 mm long; bracts and bracteoles about 1.5 mm long, subulate, rather thick. *Calyx* broadly campanulate, on herbarium specimens up to 2.5 mm long, lobed almost to the middle. *Petals* yellow or orange, about 5 mm long, oblong-obovate in upper half, narrowed into a waist and produced below into a portion with infolded margins narrowing into a claw below, stellate-pubescent dorsally about middle. *Stamens* 3.5 mm long, with broadly obovate, hyaline filaments about 2 mm long, 2.5 mm broad in upper portion, with minute hairs on shoulders; anthers almost 2 mm long, ciliate, overlapping filaments at base. *Ovary* stellate-tomentose, shallowly 5-lobed; stipe 0.5 mm long; styles 2.5 mm long. *Capsule* enveloped by persistent calyx and corolla, 5-angled, at first densely stellate-pubescent then glabrescent and membranous.

Found on rocky hills, on boulders in valleys, in loose sandy soil, among grass and on sandstone rocks. Recorded from South West Africa from Omaruru in the north, southwards to the border and beyond into Namaqualand, to Kenhardt, Gordonia and Prieska Districts in the Cape with one record from west of Luckhoff in the Orange Free State.

CAPE.—Gordonia: north of Kakamas, *Wasserfall* 1155. Kenhardt: 6.2 km N.E. of Pofadder, *Hutchinson* 940; near Kakamas, *Van der Schijff* 8067. Namaqualand: l'us, *Schlechter* 11426. Prieska: no exact locality, *Bryant* J. 108.

S.W.A.—Bethanien: Helmeringshausen, *Merxmüller & Giess* 2826. Keetmanshoop: 48 km S. of Narubis, *De Winter* 3283. Lüderitz: Numeis, *Dinter* 8077. Maltahöhe: Duwisib, *Volk* 12631; Omaruru: Erongo, *Boss* A65; Brandberg, Numas Valley, *Wiss* 1441. Rehoboth: Bullspoor, *Strey* 2183. Swakopmund: Remhoogte, *Strey* 2616. Warmbad: Sperlingspütz, *Giess, Volk & Bleissner* 6975; Warmbad, *Verdoorn & Dyer* 1778. Windhoek: Aasberge, *Dinter* 3485.

This species is close to *H. vestita*, but differs principally in the smaller flowers and the short hairs of the tomentum. The main areas of distribution are distinct. *H. minutiflora* is recorded from the central mountain plateau of South West Africa and southwards to the Arid Karoo-like southern districts along the Orange River valley, and across the border into the north-western Cape where the distribution overlaps in places that of *H. vestita*. See under that species for further notes.

44. *Hermannia althaeifolia* L., Sp. Pl. 673 (1753); Curtis's bot. Mag. t. 307 (1795); Jacq., Hort. Schoenbr. t. 213 (1797); Eckl. & Zeyh., Enum. 41, No. 322 (1834); Harv. in F.C. 1: 184 (1860), excl. syn. *H. diversifolia* (in S); Verdoorn in Flower. Pl. Afr. 41, t. 1603 (1970). Type: Cape, Cult. Hort. Cliff. (BM, holo.; PRE, photo.).

H. hirsuta Mill., Gard. Dict. ed. 8, No. 8 (1786). Type: Cape, Miller 8 (BM; PRE, photo.).

H. plicata Ait., Hort. Kew ed. 1, 2: 411 (1789). Type: Cape, cult. England, seed from Masson (BM, holo.; PRE, photo.).

Subherbaceous annuals or short-lived perennials becoming woody at base; stems branching from base with many lateral, ascending branchlets; branchlets sometimes densely stellate but pubescence throughout is of stellate hairs intermixed to a greater or lesser degree with short, patent gland-tipped hairs and long, patent, pointed hairs. *Stipules* leafy, ovate-lanceolate, the upper larger, about 1, 1 cm long (sometimes 2 cm

long), 6–8 mm broad above base, gradually acuminate to a subacute apex, usually 3-nerved or faintly 5-nerved, entire or rarely unequally lobate, pubescent as on leaves and bracts. *Leaves* petiolate; blade varying in size, large ones more or less 6 cm long, 4 cm broad, ovate, ovate-oblong or ovate-lanceolate, shallowly cordate, rounded or broadly cuneate at base; lateral veins about 3, suberect, margins sinuate-crenate, upper surface rather laxly stellate-pubescent, more densely so on lower surface, sometimes with gland-tipped hairs or long, pointed hairs intermixed; petioles of varying lengths, the longer about 3 cm long, sometimes slightly swollen and kinked near the apex. *Inflorescence* of usually 2-flowered cymes, 3 usually developing successively in axils of leaves and crowded at apices of branches and branchlets to form leafy pseudopanicles; peduncles about 25 mm long, pedicels 5 mm long; bracts 3–5 at a node, sessile, narrowly ovate to linear, varying in size, up to 5 mm long and 1–2 mm broad near base, pubescent as on other parts. *Calyx* subinflated, campanulate, about 8 mm long, lobed to above the middle, obviously pubescent with three types of hairs, stellate, gland-tipped and long, patent, acute hairs. *Petals* cadmium-yellow (and do not turn red with maturity), twisted, about 9 mm long, upper third an oblong blade narrowing abruptly into a claw with broadly infolded margins, stellate-pubescent along sides of claw (not on margins). *Stamens* with hyaline filaments about 5 mm long and 1, 5 mm broad near apex, narrowly obovate, ciliate on shoulders; anthers 3, 5 mm long, acute, ciliate. *Ovary* very shortly (0, 5 mm) stipitate, about 3 mm long, densely pubescent with stellate and long, pointed hairs, shortly 5-lobed at apex; styles cohering, acute, about 5 mm long. *Capsule* enclosed in persistent calyx and petals, 6 mm long, pubescence persistent; seeds several. Fig. 1.1.

Found in Fynbos and Renosterveld in the southwestern Cape, on mountain slopes, hills, in waste lands and sandy watercourses or in gravelly soil at roadsides. Recorded from the Peninsula eastwards to northern Mossel Bay and Uniondale, and northwards to Calvinia.

CAPE.—Calvinia: Hantam Mts, *Marloth* 10448. Ceres: Cold Bokkeveld, *Marloth* 10722. Clanwilliam: between Witte Els and Lamberts Hoek, *Pillans* 9075. Ladismith: Sevenweeks Poort, *Bayliss* 2437. Malmesbury: Swartberg, *Acoks* 20657. Montagu: on road to Barrydale, *Ellis* & *Schlieben* 12368. Mossel Bay: Cloete's Pass, *Acoks* 14633. Peninsula: *Prior* 5340; Camps Bay, *Letty* 247; Table Mtn, *Ecklon* in Herb. U.I. 392. Piketberg: *Piketberg*, *De Winter* & *Verdoorn* 9063. Swellendam: Barrydale, *Galpin* 3783. Uniondale: near Joubertina, *Marsh* 1398. Worcester: Worcester, *Marloth* 10782.

This marsh-mallow leaved *Hermannia* is characterized by its many ascending, subherbaceous branchlets, the leafy stipules, the fineness of the conspicuous pubescence and the broadly campanulate, subinflated calyx. It is related to *H. disermifolia* and *H. amoena* of Namaqualand and where their distribution areas overlaps it may hybridize with these species. The distinguishing feature is the appressed pubescence of *H. disermifolia* and *H. amoena* which covers the branchlets, as opposed to the soft spreading hairs found on *H. althaeifolia*. Several putative hybrids have been noted among specimens under the name *H. althaeifolia*.

H. aurea Jacq., Hort. Schoenbr. t. 214 (1797) may be a synonym but this cannot be judged from the painting. It seems to have less of the long, patent, acute hairs and may be a hybrid. A specimen in W., named *H. aurea*, does not match Jacquin's figure and is *H. althaeifolia* L. *H. diversifolia* Eckl. & Zeyh., Enum. No. 324 included by Harvey and I.K. as a

synonym of *H. althaeifolia* is rather *H. decumbens* (see specimen in S).

A specimen of *Ecklon* & *Zeyher* Enum. No. 323 named "*H. aurea* Jacq." in SAM is *H. althaeifolia* L.

45. *Hermannia johanssenii* N.E.Br. in Hooker's Icon. Pl. 8, t. 2709 (1905). Type: Cape, Calvinia, "Brand Vley", *Johanssen* s.n. (K, holo.; PRE, photo.!, SAM!).

Suffrutex, low, usually under 30 cm tall, when protected somewhat taller, sometimes, probably through heavy browsing, more or less prostrate with rather thick woody branches; young branches leafy to apex, completely stellate-tomentose hairs short and fine from a minute central scale, minute glandular hairs sometimes present, some stellate hairs very shortly stalked and readily falling, older branches thinly pubescent and dark coloured in contrast. *Stipules* narrowly lanceolate to oblong-lanceolate, 2–8 mm long, 1, 5–4 mm broad near base, upper usually longer than those near base of plant, minutely stellate-pubescent. *Leaves* petiolate; blade suborbicular to broadly oblong or ovate-oblong, broadly cuneate or more rarely cuneate at base, shallowly and unevenly crenate on margins, 7–19 mm long, 5–11 mm broad, subdensely stellate-pubescent to tomentose with short fine hairs from a minute central scale, minute gland-tipped hairs sometimes present; petiole 2–7 mm long, sometimes basal leaves with petioles up to 19 mm long. *Inflorescence* of short, 1–2-, rarely 3-flowered cymes in axils of leaves which usually continue to apices of branches forming long, leafy, terminal, racemose cymes with second flowers; peduncles 0–7 mm long, stellate-pubescent; bracteoles 1–2 mm long; pedicels 1, 5–4 mm long, stellate-pubescent, hairs slightly longer than on branches. *Calyx* ovoid-globose to globose, narrowed at mouth, inflated, pale, about 7 mm long, shortly toothed, teeth deltoid, up to 2 mm long, sub densely stellate-pubescent with hairs short and fine from a minute central scale, some stellate hairs shortly stalked, rays relatively long, readily falling. *Petals* twisted, yellow or "golden yellow", only shortly exerted from inflated calyx, about 9 mm long, more or less narrowly oblong in upper third, narrowing slightly into a waist and produced below into a claw with infolded margins, minutely stellate dorsally. *Stamens* about 5 mm long with narrow hyaline filaments; anthers overlapping filaments at base, ciliate. *Ovary* depressed globose, 5-lobed, about 4 mm long, 5 mm diameter, densely stellate-pubescent; stipe up to 1 mm long; styles 4 mm long. *Capsule* enclosed in persistent calyx.

Found in Western Mountain Karoo, in sandy flats, in clay, shaly ground, on dolerite ridges "among vygies". Recorded from Laingsburg District through Sutherland to Calvinia District.

CAPE.—Calvinia: Akkerendam, *Leistner* 859; Kree Kom, *Acoks* 18559; Laingsburg: Klein Roggeveld, *Marloth* 10396. Sutherland: Junction of Quaggafontein and Visrivier roads, N.W. of Sutherland, *Thompson* 1800; Waterkloof, *Marloth* 9675.

Characterized by the floriferous, tomentose branches which bear second flowers regularly arranged in the axils of leaves, in the upper half to two-thirds of branchlets. Closely related to *H. comosa*, from which it differs principally in the leaves, inflorescence and distribution. *H. johanssenii* has smaller leaves of more or less uniform size and arranged at regular, rather short intervals, reaching to the tops of the branches and consequently the axillary flowers, which are more or less of the same age and size, form a uniform

inflorescence. The distribution area of *H. comosa* lies farther to the north-east, in the False Upper Karoo from Richmond and Colesberg Districts northwards to South West Africa.

H. leucophylla Presl is a synonym of *H. comosa*, not of this species, as some have thought.

46. *Hermannia comosa* Burch. ex DC., Prodr. 1: 493 (1824); Harv. in F.C. 1: 184 (1860); K. Schum. in Engl., Monogr. Afr. Pfl. 5: 60 (1900); M. Friedrich et al. in F.S.W.A. 84: 12 (1969); Verdoorn in Flower. Pl. Afr. 41: t. 1605 (1970). Type: Cape, Asbestos Mountains, Burchell 1683 (K, holo.; PRE!).

H. leucophylla Presl, Bot. Bemerk. 20 (1844). Type: Cape, Winterveld between Nieuwjaarsveld & Ezelsfontein, Drège s.n. (named *H. plicata*) (TCD; PRE, photo. !; PRE!; LE!).

H. dinteri Schinz in Bull. Herb. Boissier 6: 748 (1898). Type: South West Africa, between Inachab and Lüderitzbucht, Dinter 6 (Z!).

H. comosa var. *crenata* K. Schum. in Engl. Monogr. Afr. Pfl. 5: 6 (1900). Type: Cape, between Griquatown and Witte Waters, Burchell 1989 (B, holo.!).—var. *minor* K. Schum. in Engl. Monogr. Afr. Pfl. 5: 60 (1900). Type: Cape, Kimberley, Bolus in Herb. norm. 324 (B, holo.!).

H. glabripetala Engl. in Bot. Jb. 55: 355 (1919). Syntypes: South West Africa, Aus, Steingröver 35 (Z!); 36 (Z!); Dinter 1062 (SAM!); Range 958 (SAM!); Pearson 5272 (SAM!) & 8222 (SAM!).

H. ausana Dinter ex Range in Reprium nov. Spec. Regni veg. 36: 260 (1934), nom. nud. based on Dinter 6058 (Z!).

Subherbaceous perennials, one to several stems arising from tap-root; stems branched at base; branches suberect to spreading-ascending, laxly sub-branched, pubescent to tomentose with fine short appressed stellate hairs often intermixed with stalked, tufted hairs. *Stipules* narrowly deltoid, linear-lanceolate, lanceolate or ovate-lanceolate, 3–6 mm long, 1–2.5 mm broad near the base, dorsally stellate-pubescent. Leaves petiolate; blade oblong to oblong-obovate, rarely oblong-elliptic, broadly cuneate to rounded at base, 1.5–5 cm long, 0.6–3.5 cm broad near base, pubescent with fine stellate hairs on both surfaces but more often densely so to tomentose underneath, sometimes partly glabrescent above, margins coarsely crenate to lobate-crenate or rarely entire; petiole densely stellate-pubescent to stellate-tomentose, often with tufted hairs intermixed. *Inflorescence* of usually 2-flowered cymes, 2–3 developing at the apices of branches and in axils of upper leaves; peduncles 5–20 mm long; pedicels 2–10 mm long; bracts subulate to linear-lanceolate, usually 3 at a node, sometimes 2 joined together, 2–5 mm long. *Calyx* inflated, white or ivory-coloured and some flowers suffused with shades of green, yellow or rose, about 9 mm long, depressed globose, 5-lobed almost to middle, with lobes incurved, pubescent on outside with short stellate hairs intermixed with longer, stalked, tufted hairs (the stalks sometimes up to 1.5 mm long). *Petals* twisted lemon-yellow, about 10 mm long, upper third oblong-orbicular, 2.5–4 mm broad narrowing into a claw 2 mm broad, lower two-thirds with infolded margins, sparsely to conspicuously dorsally pubescent with stellate and tufted hairs, especially along sides, glabrescent. *Stamens* 5 with hyaline, obovate-oblong filaments, 4 mm long, joined at base and sometimes adhering along margins to almost middle, pubescent on shoulders; anthers acute, about 4 mm long, ciliate. *Ovary* about 4 mm long, shallowly 5-lobed, stellate-tomentose, hairs fine and appressed or some, especially at apex, slightly longer and erect; styles cohering, about 6 mm long. *Capsule* enclosed in persistent calyx and petals, deeply 5-angled,

angles produced for 2 mm beyond the style bases, rounded; seeds reniform, corrugated. Fig. 2.5.

Recorded from the north-western Cape as far south as Richmond and Colesberg and northwards through the Orange Free State, the south-western Transvaal and Griqualand West to South West Africa. Found in deep sand or gravelly soil on flats or in stony ground at the foot of hills.

CAPE.—Barkly West: Barkly West, Leistner 613; Acocks 237. Colesberg: Colesberg, Bayliss 3882. Gordonias: Gordonias, Leistner 2029. Hay: Hay, Acocks 1763. Herbert: Herbert, Wilman s.n. Hopetown: Hopetown, Smith 2819. Kimberley: Kimberley, Schlieben 8711; Acocks 16; Marloth 713. Postmasburg: Postmasburg, Leistner & Joynt 2783. Prieska: Prieska, Bryant 112. Richmond: Richmond, J. Wood in TRV 19104.

O.F.S.—Bloemfontein: Bloemfontein, Hanekom 817; Burt Davy 11770. Boshof: Boshof, Burt Davy in Govt. Herb. 10153; 10346. Edenburg: Edenburg, C. A. Smith 5182. Fauresmith: Fauresmith, Pole Evans 1822; C. A. Smith 5277. Glen: Glen, Mostert 528; Heyink 22. Petrusburg: Petrusburg, Henrici 4299.

TRANSVAAL.—Bloemhof: Bloemhof, Theron 5457; Schweizer-Reneke: Schweizer-Reneke, Burt Davy in Govt. Herb. 11262.

S.W.A.—Aus: Aus, Marloth 5036; Dinter 6058 (Z); 6041; 6054; 3592. Lüderitz: Lüderitz, Van Vuuren 920; Rehoboth: Rehoboth, Töken & Hardy 704; Dinter 7977. Warmbad: Warmbad, Strahl sub Dinter 5030. Windhoek: Windhoek, Merxmüller & Gies 803.

Burchell distributed specimens of his 1683 under the name *H. comosa* and De Candolle based the species on that one specimen.

H. comosa is a variable species and several putative hybrids have been noted. The feature which probably suggested the specific epithet, namely the stalked tufts of hairs which are commonly found on the calyx, is not completely diagnostic. These comas fall readily and appear to be absent on some plants. There is also considerable variation in the density of the fine, stellate pubescence that covers all parts of the plant and often gives it a silvery grey sheen.

H. cinerascens Engl. in Bot. Jb. 55: 355 (1919) is most probably a synonym, and it is so treated by M. Friedrich et al. in F.S.W.A. The type gathering, Range 286, seen in BOL and SAM, could conceivably fall within the range of variation of *H. comosa*.

In Z, Schenk 321, which agrees with *H. comosa*, is noted as the type of *H. hottentotta* Schinz but this name was evidently never published.

47. *Hermannia incana* Cav., Diss. 6: 328, No. 473 (1788); Reichb., Ic. Descr. Pl. Cult. t. 53 (1822); Eckl. & Zeyh., Enum. 42, No. 333 (1834). Type: Cape, cult. D. Cels, Paris (MA, holo.; PRE, photo.!).

H. candicans Ait., Hort. Kew 2: 412 (1789); Jacq., Hort. Schoenbr. t. 117 (1797); Reichb., Ic. Descr. Pl. Cult. t. 55 (1822); DC., Prodr. 1: 493 (1824); Harv. in F.C. 1: 186 (1860), pro parte minore. Type: Cape, cult. Hort. Kew (BM, holo.; PRE, photo.!).—var. *incana* Harv., l.c., pro parte as to Ecklon & Zeyher Enum. No. 333 (S; PRE, photo.!). SAM!).

H. praemorsa Wendl., Bot. Beobacht. 51 (1798). Type: not traced but Wendland & Schrader 1259 in W! may be authentic; also specimens so named in Herb. Schrader (LE!).

H. mollis Willd., Enum. Hort. Berol. 692 (1809); Reichb., Ic. Descr. Pl. Cult. t. 54 (1822); DC., Prodr. 1: 494 (1824). Type: Cape, cult. Europe, Willdenow 12308 (B, holo.; PRE, photo.!).

Suffrutesc, up to 2 m tall, usually erect; branchlets whitish grey tomentose with densely fringed scales with hairs flattened to give a smooth appearance, often minute gland-tipped hairs scattered in the tomentum. *Stipules* subulate to narrowly linear or long acuminate from a 1.5 mm broad base, up to 7 mm long, 1 to 1.5 mm broad at base, tomentose. Leaves petiolate; blade ovate-oblong to broadly or narrowly oblong, broadly cuneate to cuneate at base, 7–35 mm

long, 5–20 mm broad, softly stellate-tomentose on both surfaces, at least when young, faintly to fairly distinctly undulate-crenate except at the broadly cuneate base, apex rounded or sometimes shortly acuminate and acute; petiole 3–15 mm long, softly tomentose. *Inflorescence* of 1-several-flowered, but mostly 2-flowered, cymes, one or more developing in axils of upper leaves of ultimate branchlets, forming leafy, paniculate cymes; peduncles and pedicels tomentose but not quite as smoothly as on branchlets, not of equal lengths but both varying, peduncles from 2.5–20 mm long and pedicels 2–15 mm long; bracts usually 3 at apex of peduncles, subulate, about 3 mm long, caducous. *Calyx* stellate-tomentose, subinflated, campanulate, 6–9 mm long, lobed in upper half, lobes about 3 mm long, deltoid, sinuses wide. *Petals* yellow, persistent 7–10 mm long, broadly rounded or truncate at apex, narrowing slightly at waist, claw broad with infolded margins and densely tomentose along sides. *Stamens* with hyaline, obovate filaments, minutely and sparsely pubescent on margins; anthers ciliate. *Ovary* about 8 mm long, 5-angled, stellate-pubescent, 5-umbonate at apex and shortly stipitate at base; styles adhering, at length shortly exerted. *Capsule* hidden by long-persistent petals, 5-angled, densely stellate-pubescent, 5-umbonate at apex.

Found on top of koppies, on slopes of hills and mountains in stony karroid scrub and valley bushveld. Recorded from the Peninsula through Worcester and Ceres eastwards to George.

CAPE.—George: Heimans River, *Oliver* 3579. Ladismith: Ladismith, *Bayliss* BS/1092; Amalienstein, *Acocks* 15304. Laingsburg: Whitehill, *Compton* 14875. Boschluiskloof Pan, *Leistner* 245. Mossel Bay: east of Gouritz, *Burchell* 6418 (LE). Oudtshoorn: E. of De Rust, *Dahlstrand* 1457. Peninsula: Tygerberg, *Marloth* 4478. Prince Albert: Zwartberg Mts, *Bolus* in Herb. Austro. Afr. 11720. Riversdale: Gouritz River Bridge, *Story* 2881; *Acocks* 21629; Middledrift, *Muir* 1383. Swellendam: east of Kochmanskloof, *Ecklon & Zeyher* Enum. No. 333 (S). Worcester: Veld Reserve, *Van Breda* 10; *Olivier* 128.

Schlechter 8516, named *H. disermifolia*, is *H. incana* but Vogelfontein in the Clanwilliam District is outside the known distribution area. Vogelfontein, Beaufort West is more likely.

Characterized by the smooth tomentum on the branches, the usually 2-flowered cymes in the axils of the upper leaves, leaves which are broadly cuneate at the base, usually broadest just below the middle and softly tomentose on both surfaces, and the petals which are broad and persistent, covering the capsule.

Harvey (1860), when describing *H. candicans* Ait., with four varieties, cites a number of Ecklon and Zeyher specimens listed in their "Enumeratio" under seven different names. Of these only the specimen Enum. No. 333, named *H. incana*, agrees with Aiton's *H. candicans* and is therefore *H. incana* Cav. The rest form a variable species here treated as *H. althaeoides* Link. See notes under that species.

Judging from Presl's description of *H. dregeana* in Bot. Bemerk. 20 (1844) and from a specimen, *Drège* 7301, so named in S, *H. dregeana* Presl may well be yet another synonym of *H. incana* Cav.

48. *Hermannia vestita* Thunb., Diss. Herm. 12 (1794); E. Mey. in Drège, Zwei Pfl. Doc. 60, 62, 64 (1843). Type: Cape, *Thunberg* s.n. Herb. No. 15499 (UPS, holo.; PRE, photo.).

H. candidissima Spreng. f., Syst. Veg. 18 (1828); Eckl. & Zeyh., Enum. 42, No. 331 (1834); Harv. in F.C. I: 201 (1860). Type: "C.B.S., Zeyher (n. 149)" (LE!).

Suffrutex, erect, bushy, up to about 60 cm tall but often smaller, densely tomentose on most parts with short-rayed stellate hairs radiating from a central scale, interspersed with usually longer rayed, grouped hairs on a scale which becomes detached and often with very minute, scattered, black-headed, gland-tipped, hairs; branches or branchlets often zig-zag. *Stipules* in upper parts of plant lanceolate to ovate-lanceolate, 6–10 mm long, 2–4 mm broad just above base, lower stipules smaller, 3–4 mm long, about 1 mm broad above base. *Leaves* petiolate; blade usually broadly ovate to suborbicular with a truncate or broadly cuneate base, varying in size even on same plant, from about 8 mm long and 7 mm broad just above base, to about 35 mm long and 30 mm broad (lower-most up to 45 mm long), some leaves in upper parts of plant narrowly ovate-lanceolate and cuneate in lower half, stellate-tomentose on both surfaces, strongly corrugated at least at margins, nerves prominent beneath obscurely 3-lobed as well as crenate at margin; petiole tomentose, 4–26 mm long. *Inflorescence* of 1 or more, 1–3-flowered cymes in axils of upper leaves and crowded at apices of ultimate branchlets or sometimes forming long, leafy, racemose cymes; mature flowers on herbarium specimens 6–10 mm long; bracts and bracteoles subulate to narrowly lanceolate, 2–10 mm long, up to 3 mm broad near base; peduncles and pedicels short, mostly under 5 mm long. *Calyx* not or subinflated with age, urceolate to campanulate, narrowed at mouth when young, lobed almost to middle, stellate-tomentose with short hairs, often mixed with long hairs, in mature flowers on herbarium specimens measuring from 4.5 mm to 9 mm long. *Petals* orange to lemon-coloured, about 6 to 9 mm long, more or less oblong in upper third, then narrowed into a waist with infolded margins and produced below into a claw, stellate-pubescent in parts especially in waist. *Stamens* about 4 mm long, with broadly obovate to suborbicular hyaline filaments minutely pubescent on shoulders, anthers about 2.5 mm long, overlapping filament at base, ciliate. *Ovary* 5-lobed, about 2.5 mm long, stellate-tomentose, hairs long at apex; stipe about 1 mm long; styles cohering, about 5 mm long, minutely capitate at apex, exerted from flowers. *Capsule* enveloped by long-persistent calyx and corolla, about 5 mm long, stellate-tomentose with hairs short and long, 5-umbonate at the apex. *Seeds* reniform, corrugated, 1.5 × 1 mm, minutely papillose.

Found on mountain slopes, hillsides, river banks and open veld. Recorded from the Karoo, the Cape midlands, the southern Kalahari and southern Orange Free State.

CAPE.—Barkly West: near Boetsap, *Acocks & Hafström* H 1387. Beaufort West: Farm Doornboomsfontein, *Van Breda* 535; Sunnyside, *Esterhuysen* 2705. Carnarvon: Carnarvon, *Erik Wall* s.n. (S). Colesberg: Colesberg, *Brink* 247. Cradock: near Dwingfontein, *Story* 1318. De Aar: E. of village, *Acocks* 624. Gordonia: between Olifantshoek and Upington, *Schweickerdt* 2525. Hay: Excelsior, *Acocks* 488; east of Postmasburg, *Acocks* 471; Dunmurray, *Pole Evans* 45. Laingsburg: Matjiesfontein, *Cannon* 132. Middelburg: Middelburg *Theron* 18; Conway Farm, *Gilfillan sub Galpin* 5508. Prieska: between Carnarvon and Vosberg, *Hafström & Acocks* 944. Prince Albert: Droog Kloof, *Marloth* 11291; S. of Zeekoegat, *Acocks* 22697. Somerset East: near Annsville, *Long* 746. Williston: below Jan Swartsberg, *Acocks* 18916. Willowmore: Grootrivier, Trompeterspoort, Beer Valley, *Ecklon & Zeyher* s.n.

O.F.S.—Bethulie: Nature Reserve, *Roberts* 5515. Fauresmith: Veld Reserve, *Pole Evans* 1820; *Kies* 235.

Characterized by the dense tomentum covering most parts of the plant; the broadly ovate leaves, which are only slightly longer than they are broad in

the lower half with the base truncate or broadly cuneate and the margins crenate and usually wavy, the subinflated and somewhat urceolate calyx, and the rays of the grouped hairs, which are longer in parts than on the rest of the plant. In these features *H. vestita* resembles *H. minutiflora*. As the name implies, the flowers are consistently small, under 5 mm long on herbarium specimens, as against 5.5–10 mm in *H. vestita*. The calyx does not appear to be subinflated in *H. minutiflora*, also the majority of the leaves is more suborbicular or oblate than in our species. For a comparison of the areas of distribution see notes under *H. minutiflora*.

The type of *H. candidissima* Spreng. f. is cited as "Uitenhage, C.B.S. Zeyher (n. 149)". The Uitenhage District as delimited at the time when the plant was collected, extended further north into the distribution area of the species. The plant is not known, however, from the Uitenhage District as defined today.

Specimens of *Drège* 7298 in MO and LE are obviously *H. vestita* Thunb. Harvey (1860), however, cites this number as *H. scordifolia* Jacq. var. *integriuscula* Harv. This is probably a printing error for *Drège* 7289 which is *H. scordifolia*. Common name recorded as "Katte Kruie".

49. *Hermannia amoena* Dinter ex M. Holzhammer-Friedrich in Mitt. Bot. StSamml., Münch. 1: 345 (1953); M. Friedrich et al. in F.S.W.A. 84: 13 (1969) in syn. Type: South West Africa, Lüderitz, Numeis (not "Uhabis", see photo of *Dinter* 8074 at K), *Dinter* 8074 (K; PRE, photo. !; PRE!).

H. ernesti-ruschii Dinter ex M. Holzhammer-Friedrich, l.c. 346 (1953). Syntypes: South West Africa, Lüderitz dist., Wittpüts, *Dinter* 8089; Wittpüts—Sendlingsdrift, *Wettstein* 314 (K; PRE, photo. !; PRE!).

Suffrutex, about 50–60 cm tall, erect, much branched in upper half, branchlets densely stellate-tomentose with interspersed minute gland-tipped hairs, tomentum smooth, canescent with stellate hairs of varying lengths, mostly short, radiating from or grouped on a central scale (some scales readily becoming detached). *Stipules* 5–10 mm long, 1–5 mm broad at base, large ones found towards apices of branchlets and there ovate-acuminate from a broad clasping base or semi-ovate and decurrent on branchlets, stellate-tomentose on both sides, hairs mostly short but sometimes long on margins, sometimes upper stipules glabrescent on inner face, in lower parts of plant stipules smaller, narrowly ovate-acuminate to subulate, about 5 mm long. *Leaves* petioled; blade oblong to ovate-oblong, 1.5–4 cm long, 0.5–2 cm broad, sometimes larger, stellate-tomentose on both surfaces, rounded at base and apex, crenate on margins, young leaves corrugated, nerves impressed above, prominent beneath; petiole stellate-tomentose, up to about 2 cm long. *Inflorescence* of 2- to 3-flowered cymes arranged in lax, racemose or paniculate cymes at apices of branches and branchlets and occasionally in axils of upper leaves, branches of panicle glabrescent with sparse, stellate hairs and scattered gland-tipped hairs, shiny brown in contrast to the canescent branchlets which they terminate; peduncles about 15 mm long, glabrescent; pedicels up to 5 mm long, remaining tomentose; bracts 5–10 mm long, 1–5 mm broad at base, ovate-acuminate to narrowly lanceolate; bracteoles smaller, narrowly lanceolate, linear or subulate. *Calyx* about 8 mm long, subinflated, not narrowed at mouth, subglobose or campanulate, sometimes suffused with pink in parts, lobed to about middle, stellate-pubescent without, hairs longer and softer

at base of calyx and on margins of lobes. *Petals* "golden yellow" or "orange-yellow", turning orange-red at maturity, about 11 mm long, glabrous, oblong to oblong-globose in the upper half, narrowed into a fairly short and wide waist (about 2 mm wide) and produced below into a rather wide claw with infolded margins. *Stamens* about 7 mm long; filaments hyaline, obovate, microscopically and sparsely stellate on the shoulders; anthers overlapping filaments at base, ciliate. *Ovary* about 5 mm long, 5-lobed, densely stellate-pubescent, the hairs longer at apex; styles about 5 mm long; stipe up to 1 mm long. *Capsule* about 10 cm long, hidden by persistent petals and calyx, stellate-pubescent, 5-lobed, lobes rounded at apex.

Found on granite hills or in valleys, in sand or "yellow clay", on or west of the escarpment in Namaqualand and South West Africa. Recorded frequently at Steinkopf and surroundings, northwards into the Warmbad and Lüderitz Districts of South West Africa and southwards through Spektakelberg, that is west of Springbok, to the western parts of Vanrhynsdorp.

CAPE.—Namaqualand: Steinkopf, *Theron* 1303; *Marloth* 6781; Annenous Pass, *Hardy* 2646; Steyers Kraal near Kookfontein, *H. Bolus* 6683; Oranjemund, *Lavranos* 11034; Spektakelberg, *Van der Merwe* 191. Vanrhynsdorp: E. of Vredendal, *Hall* 3645.

S.W.A.—Lüderitz: 10 km S. of Wittpüts, *Dinter* 8089; Farm Wittpüts, *Merxmüller & Giess* 3193; Numeis, *Dinter* 8074.

H. amoena is characterized by the glabrescent, slender, dark brown axis of the mature inflorescence, which contrasts sharply with the canescent tomentum of the rest of the plant, especially on the branchlets terminating in the inflorescences. Besides this diagnostic feature *H. amoena* differs from the closely related *H. disermifolia* in that the calyx of the latter is not at all inflated, the upper stipules not so large, and the hairs of the pubescence in *H. amoena* are longer and softer on some parts of the plant, usually at the base of the calices, giving a villose appearance to these parts. The main areas of distribution of the two species differ in that *H. amoena* usually occurs on or west of the escarpment, while *H. disermifolia* is found on the plateau east of the escarpment. The areas of distribution may overlap in places. Hybrids with *H. althaeifolia* are suspected.

Drège 3262 (Z), named *H. erosa* E. Mey. (a species evidently never published) appears to be *H. amoena*. According to "Zwei Documente" it was collected on Kamiesberg foothills, Kasparskraal, Ellenbogfontein and Geelbekskraal."

Holzhammer-Friedrich, when describing this species, cited the type specimen as coming from "Uhabis". A photograph of a specimen of *Dinter* 8074 in Kew shows a line drawn through "Uhabis" and "Numeis" written above it, in what appears to be Dinter's handwriting. The specimen could have been collected at either locality.

50. *Hermannia disermifolia* Jacq., Hort. Schoenbr. 1, t. 121 (1797); Reichb., l.c. Descr. Cult. t. 68, fig. 2 (1822); DC. Prodr., 1: 494 (1824); Harv. in F.C. 1: 188 (1860). M. Friedrich et al. in F.S.W.A. 84: 13. Iconotype: Hort. Schoenbr. 1, t. 121 (typotype not traced).

H. bryoniifolia sensu Eckl. & Zeyh., (as *bryonifolia*) Enum. 42, No. 332 (1834), non Burch.

Suffrutex, about 40–60 cm tall, sometimes taller, erect, branched above; branchlets persistently and smoothly canescent, stellate hairs appressed, with short rays radiating from a central scale (some scales

become detached); tomentum interspersed with minute, gland-tipped hairs. *Stipules* subulate to narrowly ovate-acuminate, upper sometimes up to 7 mm long and 2.5 mm broad near base, lower smaller, tomentose on both sides, stellate hairs short. *Leaves* petiolate; blade oblong to ovate-oblong, about 10 to 20 cm long, densely stellate-tomentose on both sides, becoming subdensely so in older leaves, surface corrugated, margin crenate and crisped, sometimes shallowly lobate as well near base, nerves deeply impressed above, prominent beneath; petiole 3–9 mm long, stellate-tomentose as on blade. *Inflorescence* of 1–3-flowered cymes terminal on the branchlets and 3 or more developing in the axils of upper leaves forming a pseudoracemose cyme, branches of inflorescence stellate-tomentose and hairs short; peduncles 4–15 mm long; pedicels 2–5 mm long; bracts linear-subulate, 4–7 mm long, sometimes narrowly ovate or oblong-acuminate, 5–7 mm long, 2 mm broad near base, occasionally 3 together and united at base. *Calyx* not obviously inflated, 5–7 mm long, lobed almost to middle, densely stellate-tomentose, hairs short, fringing a central scale. *Petals* about 8 mm long, upper third oblong, narrowed slightly into a waist and then produced into a claw with infolded margins, glabrous. *Stamens* about 5 mm long; filaments hyaline, obovate; anthers overlapping filaments at base, ciliate. *Ovary* densely stellate-pubescent, about 2.5 mm long, shallowly 5-lobed, lobes rounded at apex; stipe short, up to 1 mm long. *Capsule* 6 mm long, densely stellate-pubescent, calyx persistent at base.

Found on rocky hills, stony slopes, in dry riverbeds among rocks, and in sandy loam on sandstone hillocks. Recorded from the north-eastern area of Vanrhynsdorp District northwards into Namaqualand as far as Springbok and a few miles farther north.

CAPE.—Namaqualand: without exact locality, *Krapohl* sub *Marloth* 11162. Springbok: Springbok, *Van der Schijff* 8132; S.W. of Springbok, *Thompson* 1070; *Reynolds* 5446; E.N.E. of Springbok, *Leistner* 2538; Garies, *Schlechter* 11099; Kamiesbergen, *Ecklon & Zeyher* Enum. 332 (S). Vanrhynsdorp: "Hofkraal at Hartbeestrivier", *Zeyher* (or *Drège*) 110 (PRE; W).

H. disermifolia is characterized by the densely stellate-tomentose calyx which is not inflated, the very much corrugated leaves, and the branchlets and axis of the inflorescence being \pm smoothly stellate-tomentose with the rays of the stellate hairs short. M. Friedrich et al. in F.S.W.A. (1969) put *H. amoena* into synonymy under *H. disermifolia*, but more material of the former having come to light, it seems reasonable to keep them apart. The areas of distribution are adjacent and may overlap in part. *H. disermifolia* has been found in the northern portion of Vanrhynsdorp District and around Garies and Springbok in Namaqualand, whereas *H. amoena* comes principally from farther north, around Steinkopf and northwards into South West Africa in the Warmbad and Lüderitz Districts with a few southerly records on or near Spektakelberg, that is west of the escarpment. For further distinguishing features see the notes under *H. amoena*.

A specimen of *Ecklon & Zeyher* Enum. No. 332 in S named *H. bryoniifolia* Burch. is rather poor, but does appear to be *H. disermifolia*, as given in the Index Kewensis. It is certainly not *H. bryoniifolia* Burch.

51. *Hermannia mucronulata* Turcz. in Byull. mosk. Obshch. 31: 217 (1858); Harv. in F.C. 1: 199 (1860). Type: Cape, Uitenhage, "Van Stadensriviersberge",

Ecklon & Zeyher Enum. No. 353 (TCD; PRE, photo.; S; SAM!; LE!; W!).

H. salviifolia sensu Eckl. & Zeyh., Enum. 45, No. 353 (1834), as *salviifolia*, non L.f.

Suffrutex, 30 cm–1.25 m high, branchlets shortly tomentose with fringed scales interspersed with groups of short hairs from a scaly base. *Stipules* leaf-like, subsessile or petiole up to 1 mm long, about 15 × 4 mm, velvety tomentose on both surfaces, mucronate, somewhat cuneate at base. *Leaves* petioled; blade obovate-oblong, 15–30 mm long, 6–15 mm broad in upper half, entire, velvety pubescent on both surfaces, mucronate, cuneate at base; petiole 2–4 mm long. *Inflorescence* of few-flowered cymes in the axils of upper leaves; peduncle about 6 mm long; bracts linear to subulate, 3–10 mm long; pedicels 3–7 mm long, shortly tomentose. *Calyx* inflated to subinflated, subglobose, about 9–10 mm long, lobed in upper third, subsparingly to densely stellate-pubescent, hairs short, many in a cluster on a scaly base, lobes 2–3 mm long, more or less deltoid with narrow sinuses. *Petals* yellow, shortly exerted from calyx, about 14 mm long with the apical portion recurved, narrowed in lower third to a short waist and produced into a claw with infolded margins, shortly hairy in waist. *Stamens* about 8 mm long with broadly obovate hyaline filaments; anthers about 4 mm long, overlapping filaments at base. *Ovary* about 3 mm long, densely and shortly tomentose; stipe 1 mm long; stigmas 6 mm long. *Capsule* enclosed in persistent perianth.

Found on mountains, along slopes and in gorges. Recorded from Humansdorp, Steytlerville, Uitenhage, Port Elizabeth and Albany Districts.

CAPE.—Albany: Hounslow, *Galpin* 145. Humansdorp: Otterford area, *Oliver* 4465. Port Elizabeth: "Van Stadensriviersberge", *Ecklon & Zeyher* Enum. No. 353; Steytlerville: Slagboom, *Britten* 5813. Uitenhage: 25 km up Elands Riv. road, *Acocks* 21263; Winterhoek Mountains, *Fries*, *Norlindh & Weimarck* 1055.

Characterized by the leaf-like stipules, the stipules and leaves which are velvety tomentose on both surfaces, and by the subglobose, inflated calyx.

When Turczaninov described this species, based on *Ecklon & Zeyher*'s concept of *H. salviifolia*, Enum. No. 353, he wrote that it differed from *H. salviifolia* in the inflated calyx and that *H. salviifolia* could not be distinguished from *H. involucrata*. This suggests that he had Thunberg's sense of *H. salviifolia* in mind which I have found is *H. involucrata*. *H. salviifolia* L. f. has an inflated calyx but *H. mucronulata* differs from it principally in the velvety pubescent, entire leaves.

H. mucronulata is nearest *H. velutina* in leaf character but differs in the larger flowers and the calyx which is lobed in the upper third and not to the middle or beyond.

Putative hybrids between our species and *H. hyssopifolia* have been observed.

Much confusion exists in connection with specimens of *Drège* 7267 as seen in various herbaria. In LE, S and W it is definitely *H. mucronulata*; in MO this number is mounted on a sheet with two distinct elements and two collectors' labels. The specimen in the lower right-hand corner (nearest the *Drège* label) is *H. salviifolia* var. *grandistipula*. The other label, Krauss 1588 collected on the Winterhoek Mountains, belongs with the specimens in the upper half which are *H. mucronulata*. (See also *H. bracteosa* under Species Requiring Further Attention (p. 61). The type specimen of *H. bracteosa* Presl, in PR has the same two elements on it but only one label, *Drège* 7267.

Presl described the right-hand specimen as *H. bracteosa* and the left-hand one as *H. velutina*. The former has not been matched and appears to be a hybrid between *H. velutina* and *H. salviifolia* var. *grandistipula* while the latter is *H. mucronulata*.

52. *Hermannia suavis* Presl ex Harv. in F.C. 1: 198 (1860). Syntypes: Cape, "Zuurebergen", northern slopes, Drège 7268 (K; PRE, photo.!: W!; Z!); between Coega and Sunday rivers, Ecklon & Zeyher Enum. No. 354 (TCD; PRE, photo.!: S!; LE!; Z!).

H. involucrata sensu Eckl. & Zeyh., Enum. No. 354 (1834), non Cav.

Suffrutex, low, up to about 30 cm tall, much branched, lateral branches spreading, long, appressedly scaly and villose with loose, tufted, spreading hairs. *Stipules* broadly oblong to oblong and oblong elliptic, velvety appressed-pubescent on both faces with tufted, villose hairs intermingled on lower surface, usually 3-nerved from base on lower surface. *Leaves* crowded towards apices of branches, petioled; blade obovate to oblong-cuneate or suborbicular-cuneate, rounded or subtruncate at apex, often folded, 6–12 mm long, 4–7 mm broad (near apex), velvety tomentose on both surfaces interspersed with grouped villous hairs from a scaly or tubercled base; petiole 2–6 mm long. *Inflorescences* of crowded, short cymes at apices of branchlets and in axils of upper leaves; pedicels short, up to 3 mm long, villose; bracts (not conspicuous), caducous, subulate, about 10 × 3 mm, dorsally villose, *Calyx* villose, inflated; tube urceolate to broadly oblong, 6 mm long, narrowed at the mouth, 5-lobed in upper quarter; lobes 2 mm long, sinuses narrowly deltoid. *Petals* yellow, apparently glabrous, more or less narrowly oblong, about 10 mm long, apex reflexed, narrowed below middle in a claw with broad, infolded margins. *Stamens* about 5 mm long, filaments oblong, hyaline; anthers about 2 mm long, overlapping filaments at base, ciliate. *Ovary* shallowly 5-lobed, about 2 mm long, stellate-pubescent with pale hairs, hairs longer at apex; stipe 1 mm long; styles about 3 mm long.

Found on hills and grassy plains from the dune hills at Cape Recife northwards to the Zuurburg. Recorded from the Port Elizabeth, Uitenhage and Somerset East Districts of the Cape.

CAPE.—Somerset East: northern slopes of the Zuurburg, Drège 7268. Uitenhage: Long 1305; between Coega & Sunday rivers, Ecklon & Zeyher Enum. No. 354. Port Elizabeth: Aloes, I. L. Drège in Govt. Herbarium 3029; hill and dunes Cape Recife, Ecklon & Zeyher 1992a; Glendinning Vale Reservoir, Olivier 461.

This species is close to *H. salviifolia* var. *grandistipula*, but differs mainly in its pubescence which is pale and villose and its leaves, which are velvety tomentose on both surfaces with scattered villose hairs, whereas the leaves in *H. salviifolia* var. *grandistipula* are densely but coarsely stellate hairy on both surfaces with some of the long hairs or the stellate hairs golden yellow.

H. suavis is characterized by leaf-like stipules and an inflated calyx, besides the pale, villose pubescence which gives the plant a soft look.

53. *Hermannia hyssopifolia* L., Sp. Pl. 674 (1753); Cav., Diss. 6, t. 181, fig. 3 (1788); Reichb., Ic. Descr. Pl. Cult. t. 49, fig. 3 (1822); DC., Prodr. 1: 494 (1824); Eckl. & Zeyh., Enum. 45, No. 355 (1834); Harv. in F.C. 1: 197 (1860); Adamson in Adamson & Salter, Fl. Cape Penins. 586 (1950). Type: Cape, Cult., in Herb. Hort. Cliffortianus (BM, holo.; PRE, photo.!).

H. angularis sensu Eckl. & Zeyh., Enum. 356 (1834); sensu Reichb., Ic. Descr. Pl. Cult. t. 68, fig. 1 (1822), non Jacq.

Suffrutex, virgate with rigid branches, 36 cm–2 m high, sometimes over 2 m tall near river, new growth roughly and densely stellate-pubescent intermingled with tufted hairs on raised bases. *Stipules* varying in size from 2 mm long and subulate near base of plant to 12 mm long and 3 mm broad in upper portions. *Leaves* petiolate; blade broadest at or near apex and long-cuneate to base or oblong-elliptic, cuneate in lower half only, 9–30 mm long, 3–15 mm broad, toothed at apex only or in upper half, finely stellate-pubescent on both surfaces, sometimes densely so to velvety tomentose, glabrescent; petiole 5–8 mm long. *Inflorescence* of several bracteate cymes usually crowded at apices of branches and branchlets; bracts large, 3- or more-nerved from base, about 9 × 4 mm; bracteoles smaller, about 3–7 mm long, 1,5–3 mm broad; peduncles 4–9 mm long; pedicels 2–5 mm long. *Calyx* inflated, with 5 obtuse angles, subglobose to oblong-globose, narrowed at mouth, about 9 mm long, 6 mm diam., lobed almost to halfway but lobes broad and conniving, stellate-pubescent outside. *Petals* "lemon to yellow", "citron-yellow", "pale greenish" or "cream with red rim", narrowly oblong, about 10 mm long, slightly narrowed about midway into a claw with inrolled margins, glabrous. *Stamens* with broad, hyaline filaments about 6 mm long; anthers 2 mm long, overlapping filaments at base, minutely ciliate. *Ovary* about 2,5 mm long, densely stellate-hairy; stipe 1,75 mm long; styles 3 mm long. *Capsule* enclosed in persistent calyx, about 6 mm long, 5-angled; stipe 1,5 mm long.

Widely distributed in Fynbos, Coastal Renosterveld or Karroid Broken Veld. Found on mountain slopes or sandy plains. Recorded from the Cape Peninsula northwards to Malmesbury and eastwards to Port Elizabeth.

CAPE.—Albany: Grahamstown, Britten s.n.; MacOwan 323 (Z). Bredasdorp: Bredasdorp, Smith 3040. Caledon: Caledon, Schlechter 5412 (3 sheets); Dahlsrand 1175. Ceres: Mitchell's Pass, Schlechter 8946. Humansdorp: Humansdorp, Story 2846; Acocks 15415. Knysna: Knysna, Tyson 993. Malmesbury: Malmesbury, Marsh 1298. Mossel Bay: Cloete's Pass, Acocks 14637. Paarl: Paarl, Kruger s.n.; French Hoek Pass, Marsh 655. Peninsula: Doornhoogte, Zeyher 1995; Signal Hill, Marloth 157; 5543, 5301; Kirstenbosch, Esterhuysen 291. Port Elizabeth: near Witteklip, Rodin 1040; Enon, Thode A2610. Riversdale: near Albertinia, Muir 1770. Robertson: east of McGregor, Marsh 886. Stellenbosch: Stellenbosch, Strey 667; Jonkershoek, Boucher 514; Kruger 140. Swellendam: Appelskraal, Zeyher 1998 & 1999; Story 2887. Wellington: Wellington, Doidge s.n. Worcester: Fairy Glen, Marloth 7546.

Characterized by the inflated calyx which is usually pale greenish to lemon-yellow, narrowed at the mouth with usually citron-yellow petals shortly exerted and reflexed, by cuneate leaves toothed at the apex or in the upper half, by a fine, close stellate pubescence often with tufted hairs interspersed, and especially by the bracteate inflorescences. These bracts are like large stipules and surround the flowers. The stipules in the lower part of the plant are the smallest and increase in size upwards.

Specimens have been observed that appear to be hybrids between this species and *H. mucronulata*.

54. *Hermannia salviifolia* L.f., Suppl. 302 (1781), as *H. salviifolia*. Type: Cape, Thunberg s.n., Linn. Herb. Cat. No. 854.3 (LINN, holo.; PRE, photo.!).

Suffrutex, straggling or erect, 30 cm to 1,22 m high, branchlets and most vegetative parts roughly and densely to subdensely pubescent with stellate or

tufted hairs from a scaly, glandular or raised tubercular base, rarely some softer, whitish hairs mingled with coarse, straw-to golden-coloured hairs. *Stipules* oblong or narrowly oblong-acute to narrowly lanceolate or subulate, 3,5–10 mm long, 1,5–4 mm broad. *Leaves* shortly petiolate; blade obovate-cuneate to oblong, narrowly oblong or oblong-elliptic, apex rounded and mucronate or subtruncate and lobed, base rounded, roughly pubescent as described above; 7–35 mm long and from almost as broad to about four times as long as broad. *Inflorescence* of 1–2-flowered cymes, densely to subdensely clustered at apices of brachlets; bracts linear to subulate. *Calyx* inflated, urceolate, laxly or subdensely stellate-hairy. *Petals* somewhat longer than calyx with apical portion reflexed. *Capsule* as long as or shorter than calyx, stellate-pubescent to glabrescent.

The aggregate species is characterized by the inflated, urceolate calyx and the pubescence which is mainly of rather stiff, straw- or golden-coloured hairs from a scaly or a glandular or raised tubercular base.

With regard to the spelling of the specific name Recommendation 73G(a) of the Code is followed.

Key to varieties

Leaves from almost as broad as long to about twice as long as broad, oblong or obovate, entire, or lobed at the broadly rounded or subtruncate apex, densely stellate-pubescent:

Stipules oblong, lanceolate or subulate, small to large but less than half the size of the subtended leaf (a) var. *salviifolia*

Stipules leaf-like and half or more than half the size of the leaf, stellate pubescence dense and fairly soft in parts (b) var. *grandistipula*

Leaves narrowly oblong, up to about 4 times as long as broad, subslaxly stellate-pubescent, hairs short on a markedly dark, glandular base (c) var. *oblonga*

(a) var. *salviifolia*

H. salviifolia L. f., Suppl. 302 (1781); Harv. in F.C. 1: 193 (1860), partly; —var. *ovalis* Harv., l.c. as to Zeyher 1993 (S; PRE, photo. !; PRE!) & Drège 7280 (K, PRE, photo. !; PRE!; S; PRE, photo. !).

H. micans Schrad. in Schrad. & Wendl., Sert. Hannov. 11, t. 5 (1975); Reichb., Ic. Descr. Pl. Cult. t. 49, fig. 1 (1822); Eckl. & Zeyh., Enum. 44, No. 347 (1834). Type: Cult. Hort. Hannov., bottom right hand specimen, with the name *H. micans* written in Schrader's handwriting (LE, holo. !; PRE, photo. !).

H. latifolia Jacq., Hort. Schoenbr. t. 119 (1797). Iconotype: Figure in Hort. Schoenbr. t. 119.

H. chrysophylla Eckl. & Zeyh., Enum. 44, No. 346 (1834), pro parte as to some specimens with inflated calices, e.g. *Ecklon* & *Zeyher* Enum. No. 346 (TCD; PRE, photo. !).

Suffrutex up to 1,22 m tall; branchlets rough with tubercle-based, tufted hairs or stellate or fringed scales, often all three intermingled. *Stipules* variable, oblong, narrowly oblong or subulate, 3,5–10 mm long, 1,5–4 mm broad, usually much less than half the size of subtended leaf. *Leaves* dense towards apices of upper branchlets, shortly petiolate; blade oblong-elliptic or obovate-oblong, entire or toothed in upper portion especially at rounded or truncate apices, 10–30 cm long, 5–15 mm broad, never more than about twice as long as broad, usually roughly and coarsely stellate on lower surface, finer and more densely so on upper surface with minute, black glands intermingled, hairs straw-coloured or golden yellow, sometimes exuding a glistening substance which is clear or golden yellow; petiole up to 5 mm long, rarely 7 mm. *Inflorescence* of 1–2-flowered cymes in axils of crowded upper leaves of ultimate branchlets forming dense clusters; peduncles and pedicels very short; bracts linear to subulate usually obvious around flowers. *Calyx* urceolate, inflated, about 7 mm long, laxly to subdensely pubescent with usually long hairs

from a scaly base, lobes connivent about 2,5 mm long, sinuses narrow. *Petals* yellow, orange, "marmalade-coloured", orange becoming red with age, about 7 mm long, shortly exerted from calyx with exerted portion recurved, narrowly oblong in upper half, narrowing into a claw with narrowly infolded margins, apparently glabrous. *Stamens* about 5 mm long; filaments hyaline, oblong to oblong-cuneate; anthers overlapping filaments at base. *Ovary* 5-lobed with a short, 1 mm long, stipe. *Capsule* shorter than calyx, about 4 mm long, 4 mm in diam., enveloped by subpersistent perianth, eventually exposed and glabrescent.

Found in coastal bush and on slopes, also in passes north of the coast. Recorded from the Peninsula to Port Elizabeth and more inland from Montagu to Willowmore with one record from Graaff-Reinet.

CAPE.—Caledon: Kogel Bay, *Boucher* 498; Groot Hangklip, *Boucher* 593. George: Dysselsdorp, *Acocks* 20590. Graaff-Reinet: "Cave", *Bolus* 490. Humansdorp: Combrink, *Acocks* 13712; Kabeljaauw, *Burt* *Davy* 12048. Montagu: Cogmans Kloof, *Michell* 50. Mossel Bay: Cooper Siding, *Acocks* 24088; Gouritz River Mouth, *Drège* 7280; west of Mossel Bay, *Acocks* 15402. Peninsula: Elsie's Peak, *Pillans* 4007; near Llandudnow, *Marloth* 12745. Port Elizabeth: Parsons Vlei, *Long* 871. Riversdale: Muiskraal, *Galpin* 3784; The Fisheries, *Acocks* 21343. Swellendam: Stormvlei, *Zeyher* 1994; Hesquaspoort, *Acocks* 22389. Uitenhage: Winterhoekbergen, *Zeyher* 1993; *Drège* 9229a. Uniondale: Longkloof, *Fourcade* 1643; Mannetjesberg, *Taylor* 1463. Willowmore: Aasvogelberg, *Andreae* 948; Baviaanskloof, *Theron* 1806.

In the typical variety the leaves vary considerably in shape and are not always entire.

(b) var. *grandistipula* Harv. in F.C. 1: 193 (1860). Type: not designated.

Differs from the typical variety principally in the leaf-like stipules which are usually half or more than half the size of the subtended leaf. It also differs in the hirsute pubescence which is intermingled with the dense, harsh pubescence of the typical variety.

Found in a fairly restricted area in the eastern Cape. Recorded from the Albany, Uitenhage, Somerset East and Port Elizabeth Districts.

CAPE.—Albany: near Grahamstown, *MacOwan* 360 (GRA; TCD); Green Hills, *Britten* 5388; Coombes Valley, *Bayliss* 4309. Port Elizabeth: Port Elizabeth, *Fries*, *Norlindh* & *Weimarck* 1067 (partly). Somerset East: Kommadagga, *Burchell* 3328 (LE). Uitenhage: Uitenhage *Zeyher* s.n. in herb. Sieber Fl. Cap. No. 64 (W).

Harvey did not designate a type specimen for this variety. The specimen in TCD of *MacOwan* 360 (TCD, PRE, photo. !) from near Grahamstown has the name "*H. salviifolia* var. *grandistipula*" written on the label in Harvey's handwriting and can therefore be considered authentic, but not a type, for it was collected after 1860, the date of publication of the variety. The same collection, *MacOwan* 360, in GRA is also this species, but specimens of *MacOwan* 360 in K and Z do not have the large stipules and in all respects appear to be *H. salviifolia* var. *salviifolia*.

(c) var. *oblonga* Harv. in F.C. 1: 193 (1860). Type: not designated.

H. hyssopifolia var. *integerrima* Schinz in Mitt. bot. Mus. Univ. Zürich 66: 231 (1921). Type: Cape, George, Victoria Bay, *Schlechter* 2397 (Z, holo. !; PRE!; S!; W!).

Differs from the typical variety in the leaves being consistently narrowly oblong, more than twice as long as broad and not so crowded. The stellate pubescence is not nearly so dense and the hairs on the upper surface of the leaves are shorter and arise from a conspicuous, dark, glandular base. The flowers are usually fewer at the apices of the branchlets.

Restricted to the coast in the George and Knysna Districts and in gorges along the northern borders of these districts.

CAPE.—George: near George, *Schlechter* 5860; Victoria Bay, *Schlechter* 2397. Knysna: Wittedrift, Plettenberg Bay, *Pappe* s.n. (TCD; PRE, photo.); Hontini Pass, *Galpin* 3785; Buffalo Bay, *Keer* 869; Paarde Kraal, *Burchell* 5168 (LE); between Knysna and Avontuur, *Fries*, *Norlindh* & *Weimarck* 1637; Goukama, *Heineken* 273. Uniondale: Prince Alfred's Pass, *Acoccks* 21112; Sapree River, *Van Breda* 1173.

Harvey did not designate a type but a specimen in TCD, *Pappe* s.n., was named by Harvey "var. *oblonga*" and can therefore be considered as authentic.

55. *Hermannia holosericea* Jacq., Hort. Schoenbr. 1, t. 292 (1797); Reichb., Ic. Descr. Pl. Cult., t. 69 (1822); DC., Prodr. 1: 495 (1824); Eckl. & Zeyh., Enum. 45, No. 362 (1834); Harv. in F.C. 1: 190 (1860). Type: Cape, cult. Hort. Schoenbr., top right-hand specimen annotated by Jacquin (W, lecto.; PRE, photo.).

H. incana sensu Thunb., Fl. Cap. ed. Schult., 505 (1823), based on *Thunberg* s.n. Herb. No. 15483 (UPS; PRE, photo.).

Suffrutex 30–120 cm tall; stem erect, laxly branched from base, lower branches long and spreading, ascending; branches slender, at least new growth velvety grey-tomentose; branchlets numerous, short and slender. *Stipules* subulate to narrowly lanceolate, 2–8 mm long, velvety tomentose, early caducous. Leaves petiolate; Blade from narrowly oblong-cuneate to oblong-cuneate or suborbicular, 5–25 mm long, 2–10 mm broad, densely and finely tomentose on both surfaces, apex truncate or rounded, margins crenate in upper half or at apex only; petiole 1–10 mm long. *Inflorescence* of compound cymes, terminal on upper, ultimate branchlets; flowers sound and often crowded; peduncles and pedicels velvety tomentose; bracts linear-subulate to narrowly lanceolate, 1–3 mm long, velvety tomentose on both surfaces. *Calyx* about 3,5 mm long, stellate-tomentose without, tube turbinate, 5–10-ribbed, teeth up to 1,5 mm long, sinuses wide. *Petals* yellow, about 4,5 mm long, blade oblong, narrowed into a waist about midway where it is ciliate, lower third a claw with infolded margins. *Stamens* with oblong-elliptic hyaline filaments, 1,75 mm long, united at base and surrounding stipe of the ovary; anthers very shortly overlapping the filaments, ciliate. *Ovary* 1,5 mm long, stellate-tomentose; stipe 1,75 mm long, styles about 2,5 mm long, minutely pubescent. *Capsule* subglobose, stellate-tomentose, about 2 mm diam., surrounded by persistent calyx; stipe short, 0,5 mm long.

Found in Fynbos and Coastal Renosterveld, grassland, marginal forests, valley scrub, on lime flats, on hills and mountain slopes. Recorded from Worcester and Bredasdorp north-eastwards to Graaff-Reinet and eastwards to Albany.

CAPE.—Albany: near Grahamstown, *Schlechter* 6063 (Z); Ecklon & Zeyher Enum. 362; Hounslo, *Britten* 5680; *Galpin* 143; Alicedale, *Rogers* 37773 (Z). Bredasdorp: west of Welgelegen, *Taylor* 3788. George: Wilderness, *Levyns* 725 (BOL). Graaff-Reinet: Graaff-Reinet, *H. Bolus* 488 (Z). Ladismith: Huis Rivier Pass, *Van Niekerk* 535 (BOL). Mossel Bay: Gouritz River, *Burchell* 6421 (LE, W); *De Winter* & *Verdoorn* 9102; Little Brak River, *Sidey* 1736; near Herbertsdale, *Acoccks* 16061. Oudtshoorn: near De Rust, *Acoccks* 18281. Riversdale: Riversdale, *Acoccks* 23997; Swartklip, *Muir* 1574. Robertson: De Hoop, *Britten* 657. Swellendam: Swellendam, *Mauve* 4695. Uitenhage: between Coega and Sunday Rivers, *Zeyher* 1984; Addo, *Ecklon* & *Zeyher* 362. Willowmore: Kouga Mtns *Oliver* 4631.

Characterized by the velvety tomentose branchlets, leaves, stipules and branches and bracts of the inflorescence; the cymose panicles terminal on ultimate

branchlets with the flowers second, small and numerous. If protected, this species grows into a large, leafy bush over 1 m high and 1 m in diameter.

H. Andreae sub *Marloth* 946 from Blydeberg near Willowmore probably belongs to this species, but the hairs are longer than usual and some stipules larger.

56. *Hermannia lavandulifolia* L., Sp. Pl. 674 (1753); Curtis's bot. Mag. t. 304 (1795); Cav., Diss. t. 180, figs 1 & 1x (1788); Jacq., Hort. Schoenbr. t. 215 (1797); Reichb., Ic. Descr. Pl. Cult. t. 56, fig. 1 (1822); Eckl. & Zeyh., Enum. 45, No. 360 (1834); Harv. in F.C. 1: 199 (1860), excl. syn. *H. odorata*. Type: Cape, specimen in Herb. Hortus Cliff. (BM, photo.); PRE, photo.).

H. cavanillesiana Eckl. & Zeyh., Enum. No. 361 (1834), partly as to reference Cav. Diss., t. 180, fig. 1 (1788).

Suffrutex, weak, twiggy, 30–60 cm tall; branchlets tomentose with fringed scales and fine stellate pubescence. *Stipules* linear-subulate, early deciduous, 3–5 mm long, velvety tomentose on both surfaces (as on leaves). *Leaves* petiolate; blade oblong-obovate to oblong-obovate, 6–23 mm long, 2–6 mm broad near apex, the majority entire, velvety tomentose on both surfaces, mucronate, rarely some leaves subtruncate or with one or more lobes at or near apex, broadly cuneate at base; petiole 2–3 mm long (extension of thick midrib obvious below). *Inflorescence* of 1–3-flowered cymes, leaf-opposed; peduncle scaly-pubescent, slender, long, 4–15 mm long, usually curved downwards; pedicels short, 1–2,5 mm long; bracts like leaves and stipules but smaller, 0,5–2,5 mm long. *Calyx* about 5 mm long, turbinate, lobed to just beyond middle, scaly-pubescent without, tube 5-angled, lobes with apices often infolded, *Petals* yellow, about 6,5 mm long, upper third suborbicular, narrowed at waist, claw with broad, membranous, incurved lobes on margin. *Stamens* about 4,5 mm long; filaments hyaline, apparently glabrous, oblong-obovate; anthers ciliate, overlapping filaments at base. *Ovary* finely stellate-tomentose, hairs longer at apex, 5-lobed, 1,5 mm long with a short stipe 0,5 mm long; styles cohering, capitate at the apex, sparsely pubescent, often exerted. *Capsule* more or less hidden by subsistent perianth, about 4,5 mm long, 5-lobed, stellate-tomentose; styles long persistent.

Occurs on the south Cape coast in Renosterveld, on chalky hills, in grassy country and Valley Bush. Recorded from Bredasdorp and Caledon eastwards to Mossel Bay or just beyond.

CAPE.—Bredasdorp: Between Napier and Oudekraal, *Acoccks* 15494; Fort Beaufort, *Marsh* 816. Caledon: on slopes of Kleinberg, 0,3 km north-west of Napier, *Thompson* 3204. Mossel Bay: Ruytersbosch, *Van Niekerk* 41; Morau in TRV 19039. Riversdale: Nature Reserve, *Taylor* 7737; Plattkloof, *Muir* 471; near Wyders River, *Muir* 886. Swellendam: 27 km from Middelburg, *Story* 2888; near Heidelberg, *Acoccks* 21098.

Characterized by entire, velvety tomentose leaves (tomentum made up of fringed scales and fine stellate pubescence), distinct but short petioles, small, subulate stipules, long, slender, leaf-opposed, spreading to decurved peduncles, and scaly calyces lobed to beyond the middle.

This species was confused by Ecklon & Zeyher with *H. diversistipula* var. *graciliflora*, which they referred to as *H. cavanillesiana*.

Drège 7283 in MO is for the greater part *H. lavandulifolia* and for the lesser part *H. diversistipula* and *H. odorata*.

57. *Hermannia odorata* Ait., Hort. Kew. ed. 1, 2: 412 (1789); Reichb., Ic. Descr. Pl. Cult., t. 56 (1822); Willd., Sp. Pl. 3: 597 (1800); Pers., Syn. Pl. 2: 216 (1807). Type: Cape, cult. Kew., sine coll., sine no. (BM, holo.); PRE, photo.!).

Suffrutex up to 150 cm tall with suberect branchlets, new growth densely clothed with fringed scales, ribbed in parts. *Stipules* subulate, 3–8 mm long, up to 1 mm broad at base, usually less, velvety tomentose on both surfaces. *Leaves* cuneate into a very short petiole; blade oblanceolate to narrowly oblong-cuneate, 10–26 mm long, 2,5–7 mm broad near apex, velvety tomentose on both surfaces, usually folded along midrib which is thick and prominent beneath, acute and slightly recurved at apex, margin entire, occasionally with an odd tooth near apex; petiole up to 2 mm long. *Inflorescence* terminal on ultimate branchlets or in axils of, or opposite, upper leaves, in few-flowered pseudoracemose cymes, flowers more or less secund; peduncle short and stiff; bracts subulate, 1–2,5 mm long, usually occurring in threes (the reduced leaf and 2 stipules), reduced leaves only twice as long as stipules and stipule-like). *Calyx* about 7 mm long, lobed to above middle (sinuses V-shaped), densely yellow-tomentose without, hairs fringing pit-like scales. *Petals* twisted, yellow, about 9 mm long, upper portion oblong, about 5 mm long, abruptly narrowed into a short, densely ciliate waist (stellate-pubescent dorsally) and then into a claw with infolded margins. *Stamens* with oblong, hyaline filaments about 3 mm long, anthers pointed, ciliate, about 2,5 mm long, overlapping filaments at base. *Ovary* about 2,5 mm long, 2 mm broad, tomentose, hairs longer at apex, obscurely 5-lobed and 5-umbonate at apex; styles adhering, with a few short hairs in lower half, about 3,5 mm long; stipe under 1 mm long. *Capsule* about 5 mm long, cupped at base by persistent calyx, stellate-tomentose, 5-angled, 5-umbonate.

Found in mountainous Renosterveld, on hills and rocky slopes. Recorded from the Clanwilliam, Ceres and Montagu Districts and eastwards through Riversdale, Ladismith and Prince Albert to Uniondale.

CAPE.—Ceres: Karooport, Marloth 9032; Hafström & Acocks 939; N. of Pienarspoort, Acocks 23687. Clanwilliam: "Kerskopp", Schlechter 8798; Kromme River, Leighton 21572; Esterhuysen 20524. Ladismith: Roodeberg Pass, Lewis 5041. Montagu: North Slope. Dahlgren & Peterson 4 (GB); near Baths, Michell 144. Prince Albert: Swartberg Pass, Acocks 15526; Zand River Mountains, Muir 4334. Riversdale: near Garcias Pass, Galpin 3786. Uniondale: Joubertina, Horn SKF 2444; Acocks 20011; Mannetjesberg, Taylor 1474.

In F.C. 1: 199 *H. odorata* Ait. is treated as a synonym of *H. lavandulifolia*, but Aiton's type in BM was found to match the specimens cited here. It also matches Reichenbach's figure very well, cited above, named *H. odorata*. *H. odorata* differs from *H. lavandulifolia* in the plants being taller, more robust, the peduncles suberect instead of slender and cernuous, the calyx yellow-tomentose without and not so deeply lobed. This species is quite distinct from *Mahernia odorata* Andr., Bot. Rep. 7: 85 (1800). *M. odorata* sensu Ecklon & Zeyher, Enum. No. 405, is *H. scabra* Cav. (= *H. presliana* Turcz.).

Specimens labelled *H. fourcadii* Pillans ms. belong to this species.

58. *Hermannia sulcata* Harv. in F.C. 1: 200 (1860). Type: Cape, Sondag River near Port Elizabeth, Ecklon & Zeyher Enum. No. 359 (S, lecto.; PRE, photo.!).

H. odorata sensu Eckl. & Zeyh., Enum. 359, non Ait.

Suffrutex up to 60 cm tall, sprawling, much branched, branches slender, new growth tomentose with fringed scales. *Stipules* linear-oblancoate, sessile, acute, velvety tomentose on both sides, 5–10 mm long, about 1 mm broad. *Leaves* shortly petiolate; blade velvety tomentose on both surfaces, narrowly obovate, 12–17 mm long, 5–8 mm broad near apex, often folded, margins usually entire, occasionally some shallowly crenate in upper portion; petiole about 2,5 mm long. *Inflorescence* of leafy racemose cymes terminal on branchlets and in axils of upper leaves; peduncle slender, suberect, bracteoles linear-subulate, in threes (reduced leaf and stipules), about 2 mm long; pedicels of ultimate pair of flowers more or less the same length. *Calyx* narrowly obconic, narrowed at the mouth, 5-lobed in the upper half, often with 5 thick, prominent ribs alternating with 5 less prominent ribs, fairly densely pubescent with small fringed scales and stellate hairs, hairs long on margins of lobes; lobes about 2 mm long, acute, mucronate. *Petals* strongly twisted, yellow, sometimes partly suffused with dark red, about 8 mm long, oblong-orbicular and emarginate in upper quarter, narrowing slightly into a long waist and in lower quarter into a spur with infolded margins, minutely stellate-pubescent just behind the margin of narrowed central portion. *Stamens* about 4 mm long with oblong-cuneate hyaline filaments; anthers ciliate, overlapping filaments at base. *Ovary* about 1 mm long, shallowly 5-lobed and very shortly 5-umbonate at the apex, stellate-pubescent, especially along the lobes, hairs longer at the apex; stipe under 0,5 mm long; styles adhering, rather thick; stigma terminal, capitate.

Found on slopes, in river valleys, in clayey ground. Recorded from around Port Elizabeth, from near Grahamstown and in the Steytlerville District.

CAPE.—Port Elizabeth: Sundays River near Port Elizabeth, Ecklon & Zeyher Enum. No. 359 (S); Algoa Bay, Forbes s.n. (K); Baakens River, Long 476; Walmer, Cruden 316. Albany: north of Grahamstown, Robbertse 2. Steytlerville: Baviaanskloof Mts; Kleinrivier area, N.E. of Smitskraal, Oliver 4560.

The specimen of Ecklon & Zeyher Enum. No. 359 in S has the name *H. sulcata* written on the label in Harvey's handwriting. This specimen has therefore been selected as lectotype.

It is evidently a species with a restricted distribution. The specimens cited above are the only ones seen.

Apparent hybrids between this species and *H. velutina* have been observed in the Steytlerville district (Oliver 4517 and 4516). Their calyx is too long for *H. velutina* and the infusion of red in the centre of the petals is present as in *H. sulcata*. The leaves are more like those of *H. velutina*.

59. *Hermannia velutina* DC., Prodr. 1: 495 (1824); Eckl. & Zeyh., Enum. 45, No. 357 (1834); Harv. in F.C. 1: 199 (1860); Sim, For. Fl. Cape Col. 146, t. 15 (1907). Type: Cape, Somerset East, "Zwartwater Poort", Burchell 3393 (K; PRE, photo.!, PRE!; LE!).

Frutex, slender, erect, 70 cm to 3 m high, branches rather slender, new growth pubescent to velvety tomentose with minute fringed scales and stellate hairs, glabrescent. *Stipules* leaf-like, elliptic-cuneate to oblanceolate-elliptic, 3–20 mm long, 1–6 mm broad, sessile or shortly petiolate, velvety tomentose on both surfaces, mucronate. *Leaves* petiolate; blade broadly to narrowly oblong-elliptic, or oblanceolate-elliptic, 5–50 mm long, 2,5–20 mm broad, velvety tomentose on

both surfaces, mucronate, often folded along midrib, midrib impressed above, prominent beneath; petiole 2–10 mm long. *Inflorescence* of short, paniculate cymes terminal on branchlets and in axils of upper leaves, 2.5–6 cm long; bracts early caducous, terete, up to 9 mm long, tomentose; pedicels short, 2–6 mm long. *Calyx* campanulate, 5–7 mm long, lobed to middle or beyond, pubescent with scale- or tubercle-based hairs, drying thin. *Petals* usually only slightly longer than calyx, from about 6 to 8 mm long, oblong to suborbicular in upper third, narrowed to a ciliate waist and produced in lower third into a claw with broadly infolded margins. *Stamens* about 5 mm long, filaments hyaline, obovate, obscurely pubescent on shoulder, anthers about 3 mm long, ciliate, overlapping filaments at base. *Ovary* finely pubescent with longer hairs at the apex, 5-angled and 5-umbonate at apex; stipe small, up to 0.75 mm long; styles cohering, about 2.5 mm long. *Capsule* enclosed in persistent perianth, about 5 mm long, finely stellate-tomentose but hairs longer at apex of capsule.

Occurs on rocky slopes at forest margins, along rivers, in open grassveld, on sand dunes and in Coastal Fynbos. Recorded from Humansdorp eastwards through the Transkei to Natal and inland as far as Somerset East.

CAPE.—Albany: Coombes Valley, *Bayliss* 4310; Grahamstown, *Rogers* 28683; Stone's Hill Range, *Galpin* 160. Alexandria: Nanaga, *Acoccks* 12797; *Story* 1309. Bathurst: Three Sisters, *Britten* 702; Buffalo River, *Galpin* 1871. Humansdorp: Humansdorp, *Rogers* 2828; *Wells* 2948; Klipdrift, *Thode* A2463. Kentani: Kentani, *Pegler* 453; Nomaheya Forest, *Strey* 6712. Komga: Komga, *Flanagan* 510. Port Elizabeth: Vaal Vlei Estate, *Mogg* 5379; Baakens River, *Long* 478. Somerset East: "Zwartwater Poort", *Burchell* 3393. Uitenhage: between Coega and Sundays Rivers, *Zeyher* 1989; Groendal, *Long* 1160. Victoria East: Pepperskop, *Alice*, *Acoccks* 9761.

NATAL.—Durban: Malvern, *Medley* Wood 11846 (NH). Isipingo: Isipingo, *Ward* 893; 5889; between "Omcomas and Omlas", *Drège* s.n. (S).

Characterized by the velvety leaves which are entire and petioled, the leafy stipules, campanulate calyx and leafy panicles.

This species usually occurs as a robust plant, but sometimes it is twiggy with small leaves and very small flowers. Specimens representing this small form are *Zeyher* 1989 in PRE, a PRE specimen originally from Herb. Sonder, labelled with the Enum. label No. 359 *H. odorata*, but named *H. sulcata* by Tych. Norlindh in 1939 and probably also the lower specimen on No. 311334 in W (labelled *H. odorata*) (the upper is *H. diversistipula*).

On many herbarium specimens the author is given as Burchell, but DC. actually published the species with Burchell's specimen as type.

In leaf character, *H. velutina* approaches *H. mucronata* Turcz., but differs in the inflorescence and the smaller flowers with the calyx lobed to the middle.

Specimens which appear to be hybrids between *H. velutina* and *H. sulcata* have been observed.

60. *Hermannia gracilis* Eckl. & Zeyh., Enum. 45, No. 358 (1834); Harv. in F.C. 1: 200 (1860). Type: Cape, Graaff-Reinet, *Ecklon* & *Zeyher* Enum. No. 358 (S!; PRE, photo.!).

Suffrutex with slender branchlets, 90–120 cm tall, new growth thinly tomentose with fringed scales, glabrescent. *Stipules* leaf-like, narrowly elliptic to oblanceolate-elliptic, 5–20 mm long, 1–4 mm broad, acute at apex, cuneate at base, sometimes cuneate into a petiole up to 3 mm long, velvety tomentose on both surfaces, sometimes fairly thinly so. *Leaves* usually

shortly petiolate; blade narrowly elliptic-cuneate to oblanceolate-elliptic or oblong-cuneate, 10–23 mm long, 4–8 mm broad, often acute at apex, cuneate at base, margins entire or rarely with a few teeth in upper portion, velvety tomentose on both surfaces, sometimes fairly thinly so; petiole 2–5, 5 mm long. *Inflorescence* a few-flowered racemose cyme terminal on the lateral branchlets. *Calyx* tubular, campanulate, about 7 mm long, tomentose with short stellate hairs, minute gland-tipped hairs and fringed scales, lobed to above middle, subglabrescent, lobes acute to subulate from a deltoid base, about 2 mm long, sinuses wide, u-shaped, margins pubescent. *Petals* "yellow and red", "dull yellow", "orange", "rather pale yellow" or "brownish yellow", contorted, about 10 mm long, exceeding calyx, upper half broadly oblong, emarginate, narrowing into a long claw with infolded margins, pubescent along sides in centre. *Stamens* about 5 mm long, with hyaline, narrowly oblong filaments united for less than 1 mm at base around short stipe; anthers acute, ciliate. *Ovary* about 4 mm diam., subglobose, obscurely 5-lobed and 5-umbonate at apex, stellate-tomentose hairs short but longer towards apex of ovary; stipe almost 1 mm long; styles adhering; stigma small. *Capsule* exerted from calyx remains, about 7–8 mm long, pubescent with stellate hairs, hairs short except along sutures and at apex.

Found in karroid bushveld, on rocky slopes, in river valleys and karroid scrub. Recorded from Steyterville and Graaff-Reinet Districts eastwards to the Fish and Kat River valleys.

CAPE.—Albany: near Grahamstown, *Dyer* 519; 1377; Brak-Kloof, *Acoccks* 12044; Pluto's Vale, *Story* 2278; Botha's Hill, *Schlechter* 6086. Bedford: N. of Camerons Glen, *Acoccks* 12802; 12803; Koonop Heights, *Britten* 2047; on banks of Baviaans River, *Theron* 1051. Graaff-Reinet: Wimbeldon, *Henrici* 4933. Jansenville: N.E. of Jansenville, *Comins* 818. Port Elizabeth: Coega, *Bayliss* BS 2271 (MO). Steyterville: N.W. of Patentie, *Story* 2441. Uitenhage: Kirkwood area, *Hardy* 3815; Winterhoek, *Krauss* 1590 (MO).

61. *Hermannia diversistipula* Presl ex Harv. in F.C. 1: 198 (1860); Presl, Bot. Bemerk. 21 (1844), nom. nud. Type: Cape, Swellendam, Breede River, *Drège* 7274 (K, holo.; PRE, photo.!).

Suffrutex, branches erect to spreading, ascending or long and distichously arranged, clothed with fringed scales. *Stipules* leaf-like, sessile, linear-acute to elliptic, oblong-obovate or oblong-elliptic, 3–10 mm long, 0.75–3.5 mm broad, scaly-tomentose on both surfaces. *Leaves* subsessile or narrowed into a short petiole; blade 5–20 mm long, 2–10 mm broad at apex, cuneate at base, apex rounded or truncate, sometimes lobed, mucronate, usually conduplicate with small mucro slightly recurved, scaly-tomentose on both surfaces; petiole up to 3 or rarely 5 mm long. *Inflorescence* of short, usually 2-flowered, axillary cymes, flowers nodding and usually secund. *Calyx* lobed to about middle or almost to middle, scaly-tomentose outside, lobes deltoid or oblong, mucronate, apices often incurved. *Petals* twisted in upper portion, garnet-red or chrome-yellow, about 10 mm long, upper third broadly oblong, narrowing into a central waist, produced into a claw with infolded margins in lower third, minutely stellate-pubescent on margins in centre and on edges of claw. *Stamens* with hyaline oblong-elliptic filaments, about 3 mm long; anthers 1.5–2.5 mm long, cells acute, minutely ciliate, overlapping the filaments at base. *Ovary* 2–3 mm long, obscurely 5-angled and 5-umbonate at apex, scaly-pubescent and stellate-pubescent at apex; stipe

almost 1 mm long; styles cohering, minutely pubescent. *Capsule* 5–7 mm long, 5-umbonate at apex, finely stellate-pubescent, more coarsely so at apex. *Seeds* reniform, 1, 5 mm long.

Found in stony soil on hill tops with karroid shrubs, also in river flats, valley bush, Coastal Renosterveld and Fynbos. Recorded from Tulbagh District and south-eastwards to George.

The aggregate species is characterized by the rather small, velvety tomentose, mostly entire leaves, the leaf-like stipules and the nodding, often second flowers which are axillary and occur singly or in pairs on fairly short peduncles. The tomentum is made up of fringed scales intermingled with fine stellate hairs.

Key to varieties

- Calyx over 5 mm wide at the mouth, with broad lobes; branches several from a thickened woody rootstock; stipules almost as long as the leaves.....(a) var. *diversistipula*
 Calyx tube narrow, under 5 mm wide at the mouth; suffrutex up to 90 cm tall with slender, distichous branches; stipules about half as long as the leaves.....(b) var. *graciliflora*

(a) var. *diversistipula*

Verdoorn in Flower. Pl. Afr. 41, t. 1620 (1970).

H. diversistipula var. *nana* Harv. in F.C. 1: 198 (1860). Type: Cape, Storm Valley, Breede River Poort, Zeyher s.n.

Suffruticose perennial with several spreading, ascending to erect branches from a thickened woody rootstock; branchlets clothed with fairly coarse, fringed scales. *Stipules* oblong-elliptic to oblong-obovate, 2–8 mm long, 1–3, 5 mm broad in upper half, velvety tomentose on both surfaces with fringed scales. *Leaves* sessile to subsessile; blade cuneate from a rounded or obtuse apex, conduplicate, 3, 5 to 12 cm long, up to 6 mm broad at apex, velvety tomentose on both surfaces with fringed scales, apex rounded or broadly obtuse and lobed. *Inflorescence* axillary in upper leaves (usually only the 3 upper leaves); peduncles 2–5 mm long; pedicels 2 mm long, bracts linear, about 2 mm long. *Calyx* scaly-tomentose, about 5 mm to 7 mm long, lobed to about middle, lobes more or less oblong, up to 3 mm broad, apical portion incurved. *Petals* red or yellow, about 10 mm long. *Capsule* subglobose, shortly exserted from calyx, 5-umbonate at apex.

Found on level stony soil on hilltops with karroid shrubs, on shale hillocks in valley bush and on river flats. Recorded from the Malmesbury District eastward to Swellendam District.

CAPE.—Bredasdorp: between Elandsdrift & Wiedsdrift, *Dahlgren & Peterson* 440a; (G.B.); Klipdale, *Smith* 3200; *Kykhoedie*, *Acoks* 22724. Caledon: west of Rietpoel, *Taylor* 3756; 23 km from Caledon on way to Swellendam, *Story* 3070. Malmesbury: Lucasfontein near Oupos Hotel, *Acoks* 24302. Swellendam: Breede River, *Drège* 7274; Bontebok Park, *Acoks* 22567. Tulbagh: Ceres Road (Wolseley), *Schlechter* 8988; Saron, *Schlechter* 7871 (LE; BOL).

Although the areas of distribution of the varieties overlap to some extent and are approximate, the typical variety seems to favour higher regions in karroid shrub, whereas var. *graciliflora* is found at lower levels in Coastal Renosterveld or Fynbos.

(b) var. *graciliflora* Verdoorn in Flower. Pl. Afr. 41, t. 1620 (1970). Type: Cape, between Heidelberg and Witsand, *De Winter & Verdoorn* 9095, cult. PRE 20920 (PRE, holo!; K!).

H. cavanillesiana Eckl. & Zeyh., Enum. 45, No. 361 (1834) partly, as specimen *Ecklon & Zeyher* from between Hassaquaakloof and Breede River (TCD; PRE, photo!; PRE!; LE!); sensu Harv. in F.C. 1: 199 (1860) as to *Ecklon & Zeyher* specimen cited.

Suffrutex up to 90 cm high with spreading branches which are distichous and densely to sparsely pubescent with minute fringed scales. *Stipules* linear-acute to narrowly elliptic, 3–10 mm long, 0, 75–3, 5 mm broad, tomentose on both surfaces with minute fringed scales and stellate hairs, sometimes with minute glands intermixed. *Leaves* subsessile or shortly petiolate; blade tomentose on both surfaces, tomentum as on stipules, oblanceolate to obovate, cuneate at base, usually conduplicate, 4, 5–20 mm long, 2–10 mm broad near apex, entire, apex broadly acuminate with a small recurved mucro; petiol up to 3 mm long rarely up to 5 mm. *Inflorescence* of usually 2-flowered cymes, axillary, flowers second; peduncle 2–5 mm long; pedicels 1–3 mm long, bracts up to 5 at base of pedicels variable and linear-lanceolate to ovate-lanceolate, simple or 3-lobed, lobes up to 3 mm long, acute. *Calyx* about 5 mm long, lobed almost to middle, obscurely 5-angled, tomentose without, lobes deltoid, acute or acuminate, apices sometimes strongly in-curved. *Petals* red or yellow, about 9 mm long. *Capsule* about 5 mm long, eventually half exserted from persistent calyx, 5-angled, 5-umbonate at apex.

Found in Fynbos, Coastal Renosterveld and valley bush along the southern Cape coast. Recorded from the Caledon District eastwards to George and Uniondale.

CAPE.—Bredasdorp: 33 km E. of Bredasdorp, *Marsh* 941; Kathoek, *Acoks* 22597. Caledon: Zwartberg in the vicinity of the Baths, *Zeyher* 1988. George: near Camfer Station, *Acoks* 22343. Mossel Bay: Mossel Bay, *Sidley* 1741; *Acoks* 15398; near Cooper Siding, *Acoks* 24094. Oudtshoorn: De Rust, *Acoks* 20458. Riversdale: Gouritz River, *Drège* 7272; *Marsh* 576; Tygersfontein, *Galpin* 3790. Swellendam: between "Hassaquaakloof and Brede River", *Ecklon & Zeyher* s.n.; between Heidelberg and Witsand, *De Winter & Verdoorn* 9095; *Marsh* 935; *Mauve* 4786; *Bonnievale*, *Marloth* 11834. Uniondale: 1 km N. of Uniondale, *Ellis* 16396.

Besides the diagnostic characters mentioned in the key, that is the difference in habit, calyx and stipules, there are other features that may assist in distinguishing the two varieties. In var. *diversistipula* the fringed scales are usually larger, the leaves, which hardly exceed the stipules, are often lobed at the apex and the flowers are usually found in the axils of only the upper three to five leaves. In var. *graciliflora* the fringed scales are minute, the leaves which overtop the stipules by about half are entire at apex and flowers usually arise in the axils of leaves along the upper half or two-thirds of the branchlets.

62. *Hermannia cuneifolia* Jacq., Hort. Schoenbr. 1, t. 124 (1797). Type: Cape, cult. Hort. Schoenbr., two flowering twigs on left hand of sheet, with the name, in Jacquin's handwriting, on the label (W, lecto!; PRE, photo!).

Suffrutex, usually heavily browsed, varying in height from 15–90 cm tall, rigid, erect or spreading, much branched, branchlets very sparsely to very densely lepidote-stellate and then silvery grey in appearance. *Stipules* from small and subulate from a broad base to broadly ovate in upper parts of plant, base broad and sometimes subcordate, apex acute or acuminate, up to about 3, 5 mm long and 3, 5 mm broad at base, pubescence as on leaves but with a few long hairs at apex or also on margin near apex. *Leaves* appearing fasciated when crowded on abbreviated shoots, shortly petiolate; blade dull grey-green to silvery grey, concolorous, cuneate, from about 6–18 mm long, 3–10 mm broad at apex, truncate, bi-lobed or broadly rounded and coarsely crenately

lobed at apex, sometimes conduplicate, upper and lower surfaces from sparsely to densely tomentose with fringed pitted scales (lepidote-stellate), lateral nerves usually obscure; petiole 1–9 mm long. *Inflorescence* a raceme of second, 1–2-flowered cymes terminal on ultimate branchlets, or cymes 3–5 congested at apices of short, lateral branchlets; peduncles very short (1 mm long) and spreading or about 4 mm long and then strictly erect; bracts 2–3 or more at a node and sometimes with an entire, elliptic bract among them, broadly ovate, usually about 3–4 mm long, 2–4, 5 mm broad at base, semi-amplexicaul, sometimes united, cucullate, sometimes with bristle-like hairs on margins and apex; pedicels 1–5 mm long, cernuous. *Calyx* campanulate, about 6 mm long, lobed to about one third the length, laxly to very densely lepidote-stellate, the scales and hairs straw-coloured or some light reddish brown. *Petals* bright yellow to dark orange-red, up to about 5–10 mm long, narrowed at base into a claw, claw glabrous to densely pubescent along margins, lower portion with inrolled margins. *Stamens* with hyaline, oblong-ovate filaments, a few hairs on shoulders; anthers 3 mm long, pointed, ciliate. *Ovary* densely lepidote-stellate (hairs short), shallowly 5-lobbed, shortly stipitate; stipe 1 mm long; styles about 5 mm long. *Capsule* lepidote-stellate, about 7 mm long.

Found along the eastern margins of the winter-rainfall area and from there eastwards to the Great Fish River and northwards to Namaqualand, the southern Orange Free State and Lesotho.

Key to varieties

- Flowers second, about 9 mm long; calyx and leaves, at least on lower surfaces, densely lepidote-stellate. . . (a) var. *cuneifolia*
 Flowers 3 to 5 in a cyme, congested at apices of numerous short, lateral branchlets about 5, 5 mm long, leaves fairly sparsely to sparsely lepidote-stellate on both surfaces. (b) var. *glabrescens*

(a) var. ***cuneifolia***. Verdoorn in *Bothalia* 10, 1: 79 (1969).

H. cuneifolia Jacq., Hort. Schoenbr. 1, t. 124 (1797); Reichb., Ic. Deser. Pl. Cults. t. 60 (1822); DC., Prodr. 1: 495 (1824); Harv. in F.C. 1: 189 (1860), partly, excluding syn. *H. multiflora* and specimen cited. Type: Cape, cult. Hort. Schoenbr., two flowering twigs on left hand of sheet with the name, in Jacquin's handwriting, on the label. (W, lecto.; PRE, photo.!).

H. pallens Eckl. & Zeyh., Enum. 48, No. 378 (1835). Harv. in F.C. 1: 190 (1860). Type: Cape, Uitenhage between Cosga and Sundays Rivers, Ecklon & Zeyher Enum. No. 378 (K; PRE, photo. PRE!; S!; NBG!).

H. secundiflora Eckl. & Zeyh., Enum. No. 380 (1835). Type: Cape, Caledon, Potrivier, Langehoogde et Bontjes Kraal, Ecklon & Zeyher Enum. No. 380 (PRE!; S!).

H. lepidota Buch. ex Krauss, Flora 27: 294 (1844), nom. nud. based on Krauss s.n. from Winterhoek (W!; PRE, photo. LE).

H. membraniflora Schltr. in Bot. Jb. 55: 359 (1919). Type: Cape, Vanrhynsdorp: Pappelfontein, Onderbokkeveld, Schlechter 10911 (K; PRE, photo. PRE! BOL!; S!; LE!).

The typical variety is a more robust plant and is reported to be more palatable than var. *glabrescens*; flowers are larger and second on lateral branchlets and petals usually densely pubescent on margins of claw. The dense lepidote-stellate pubescence gives branches and leaves a silvery grey appearance especially in eastern and northern regions. Under the microscope this pubescence is seen to be composed of pitted scales fringed with hairs.

Found in marginal Fynbos from Bellville in the south-western Cape northwards to Namaqualand and eastwards through the Broken Veld and Arid Karoo to the Alexandria and Middelburg Districts.

CAPE.—Alexandria: Addo National Park, Archibald 3751. Beaufort West: Oukloof Pass, Acocks 14332. Bellville: near Durbanville, Taylor 4963. Bredasdorp: Napier, Compton 8989 (NBG); Klipdale Station, Smith 3196. Caledon: Potrivier, Langehoogde et Bontjeskraal, Ecklon & Zeyher Enum. No. 380 (S). Calvinia: Calvinia, Acocks 14442; Schmidt 49: 164, 312. Carnarvon: Carnarvon, Leistner 482. Ceres: Ezelsfontein, Esterhuysen 20361. Clanwilliam: Clanwilliam, Acocks 19667; Olifants River near Rondegat, Schlechter 5045. Cradock: Rayner's Koppie, Acocks 11922; Dwingsfontein, Story 1319; Baroda, Dyer 1037. De Aar: De Kalk, Henrici 4522. Fraserburg: Hafström & Acocks 942. Graaff-Reinet: Klipfontein, Codd 3530. Ladismith: Acocks 14608. Laingsburg: Whitehill, Compton 11202 (NBG). Middelburg: Conway Farm, Gilfillan sub Galpin 5504; 5505. Mossel Bay: Sidey 1742; Acocks 15396. Namaqualand: West of Kamieskroon, Acocks 16454. Paarl: Paarlberg, Bos 368. A. Richmond: Elandskuilen, Acocks 8732. Riversdale: east of town, Acocks 21377; Onverwacht, Muir 1608. Robertson: Robertson, Van Breda & Joubert 1921. Somerset East: Aansville, Long 747; Sheldon, Mrs Hutton 12399; Kommadagga, Bayliss 1619. Stellenbosch: Klapmuts, Esterhuysen s.n.; Taylor 5034. Steytlerville: Barroe, Story 2307. Swellendam: Swellendam, Martin 249 (NBG); near Heidelberg, Barker 5567 (NBG; BOL). Uitenhage: Winterhoek, Burchell s.n. (LE; W); between Cosgo & Sundays River, Ecklon & Zeyher Enum. No. 378 (type gathering of *H. pallens*). Vanrhynsdorp: Heerelgement, Zeyher s.n. (S); Pappelfontein, Schlechter 10911; north of town, Acocks 14744. Victoria West: Rehm s.n. Willowmore: Theron 1369. Worcester: Mowers Siding, Acocks 14541.

In the past this species has gone under the name *H. pallens* Eckl. & Zeyh., mainly owing to Harvey's (1860) misidentification of *H. cuneifolia* Jacq. See notes under *H. multiflora* for particulars.

Although *H. cuneifolia* var. *cuneifolia* is widely spread from west to east, and consequently varies in some respects, it is clearly definable as a unit. It is evidently very palatable to browsing animals, for most specimens show signs of having been eaten down continuously. The flowers are said to be sweetly scented. Acocks reports that this variety has advanced and still is advancing eastwards and northwards into the ecological vacuum caused by the withdrawal of the grassveld.

This variety is close to *H. pfeilii* K. Schum., and *H. Bolus* 6081 and Acocks 14994 from Namaqualand appear to be intermediates, with the pubescence on the leaves like that of *H. pfeilii* but the calyx more like that of *H. cuneifolia* var. *cuneifolia*.

H. triphylla sensu Eckl. & Zeyh. Enum. No. 379 (as represented in SAM) is *H. cuneifolia*.

(b) var. ***glabrescens*** (Harv.) Verdoorn in *Bothalia* 10, 1: 79 (1969). Type: Without locality, Drège s.n. (K, lecto. PRE, photo. W!).

H. pallens Eckl. & Zeyh. var. *glabrescens* Harv. in F.C. 1: 190 (1860), partly as to Drège specimen cited, excluding Mrs Barber, Albany.

This variety differs from the typical in that the shrublets are generally 30–60 cm tall, more repeatedly branched, the branchlets shorter, rigid and early glabrescent; the leaves are more sparsely lepidote-stellate, the inflorescence is congested at the apices of numerous, short, lateral twigs, usually with only 3 to 5 flowers in each cyme; the flowers are smaller, just over 5 mm long (instead of 8–10 mm long), the calyx more narrowly campanulate and slightly narrowed at the throat, and the petals glabrous or nearly so and cuneate into the claw instead of distinctly ciliate to densely pubescent along the margins and abruptly narrowed into the claw.

Found in stony ground, mainly in the transitional zone between Karoo and grassland, which stretches roughly from the vicinity of Beaufort West north-eastwards in a widening band through Middelburg to

Aliwal North and through Herbert District into the Orange Free State, reaching Lesotho in the east.

CAPE.—Aliwal North: Aliwal North, Thode A1840. Beaufort West: Nieuwveld Mts, Esterhuysen 2748; Marloth 2138; Sunnyside, Esterhuysen 5056. Colesberg: Colesberg, Botha in BLFU 7547. Cradock: Cradock, Brynard 43; Modderfontein, Acocks 12811. Herbert: Thornhill, Leistner 1422. Middelburg: Middelburg, Horn s.n.; Conway Farm, Gilfillan sub Galpin 2955; 5507. Murraysburg: Murraysburg, Van Heerden 1; Tyson 271 (SAM). Richmond: Leopard's Vlei, Bolus 13852.

O.F.S.—Bloemfontein: Bloemfontein, Gemmell in BLFU 6440; Thode A521; De Winter 8969; Grants Hill, Wasserfall 219 (BOL). Fauresmith: Fauresmith, Smith 413; 4541; Henrici 1815; 1864; Verdoorn 1140. Philippolis: Philippolis, Smith 4485; 4497. Rouxville: Ecklon & Zeyher loc. 114 in Linnaea 19. Thaba Nchu: Thaba Nchu, Roberts 2666. Zastron: Zastron, Maree 1.

LESOTHO.—Leribe: Dieterlen 755.

According to "Zwei Documente" the Drège specimen of *H. multiflora*, on which Harvey based his *H. pallens* var. *glabrescens*, was collected in the Hexrivierbergen, Bokkeveld, that is Ceres District, slightly outside the known distribution but it could possibly occur there. The specimens agree with those collected further north.

In Flora Capensis 1: 190 Harvey suggested that var. *glabrescens* was possibly *H. multiflora* Jacq. This has proved to be incorrect (see notes under *H. multiflora* Jacq.).

Some specimens from outside the known distribution area appear to be intermediates or hybrids between these varieties.

According to reports, the leaves when squashed form a sticky mass which is considered to have a healing effect when applied as a plaster to sores. This accounts for the common name "Geel pleisterbossie", generally used in the Orange Free State. The prefix "geel" (meaning yellow) is misleading because the flowers may be bright yellow on some plants or orange-red on others.

Burke & Zeyher 122 in S is typical *H. cuneifolia*, but it could hardly have been collected on the Orange River.

63. *Hermannia desertorum* Eckl. & Zeyh., Enum. 48 (1834); Harv. in F.C. 1: 189 (1860). Type: Cape, near Graaff-Reinet, Ecklon & Zeyher Enum. No. 382 (K; PRE, photo.!; S!; SAM!).

Suffrutex, usually heavily browsed, if protected, about 60 cm tall with slender, divaricate branchlets becoming indurated, branches chestnut-brown, drying dark brown or with slight metallic sheen, young growth with a fine, greyish, sericeous tomentum made up of microscopic fringed scales and stellate hairs. *Stipules* subulate from a broad base or ovate-cuspidate, 2–3 mm long, covered with a thin grey tomentum. *Leaves* shortly petiolate; limb suborbicular, broadly cuneate into the petiole, from 5×5 mm to 8×7 mm, plicate at first and covered by a thin greyish rather sericeous tomentum, becoming glabrescent on upper surface, older leaves sometimes stellate-pubescent on both sides, broadly rounded at apex, deeply and broadly crenate except at base; petiole 2–5 mm long, pubescence as on leaf undersurface. *Inflorescence* terminal, in few-flowered, racemose cymes, (sometimes 1-flowered and second-hybrids?); peduncles and pedicels varying from very short, about 2 mm long, to 5 mm long, pubescence as on young branchlets; bracts 1,5–2,5 mm long, rather thick, broadly ovate to subulate from a broad base. *Calyx* thin-textured in dried specimens, subinflated, 5-gibbose, about 5 mm long, wide at mouth, lobed to

near middle, finely pubescent with minute fringed scales. *Petals* yellow, minutely papillose within, upper half more or less oblong-orbicular, abruptly narrowed into a waist and produced below in a claw with margins inrolled, claw sometimes strongly arcuate, appears glabrous, but a few microscopic hairs present. *Stamens* ±4–5 mm long, with obovate-oblong, hyaline filaments which appear to be glabrous but have microscopic hairs on shoulders, united at base; anthers ciliate, overlapping filaments at base. *Ovary* broad, 5-lobed, very shortly stipitate, finely stellate-tomentose. *Capsule* about 4×4,5 mm, stellate-tomentose, shallowly 5-lobed.

Found in karroid broken veld, on the jasper hills and in pan-like depressions with compact calcareous sand. Recorded from Laingsberg and Prince Albert in the south and northwards through Vanrhynsdorp and Prieska to Witpütz in South West Africa.

CAPE.—Beaufort West: N.W. of Bulwater, Acocks 14140. Calvinia: N. of Calvinia, Municipal Reserve, De Winter & Verdoorn 9009. Carnarvon: W. of town, De Winter & Verdoorn 9005. Clanwilliam: Clanwilliam, Boucher 3106. Graaff-Reinet: near town, Ecklon & Zeyher Enum. No. 382 (SAM). Hay: Floradale, Esterhuysen 2321; Lanyon Vale, Acocks 1962. Laingsburg: Zoutkloof, Compton 6434 (NGB). Postmasburg: near Olifantshoek, Leistner & Joynst 2781. Prieska: Prieska, Bryant 3383. Prince Albert: Zwartberg Pass area, Stokoe 9036. Vanrhynsdorp: Komkas, Acocks 23301.

S.W.A.—Lüderitz South: Witpütz, Merxmüller & Giess 28770.

Characterized by the fine, pale, stellate pubescence, the semi-inflated, shallow calyx, 5-gibbose at the base, the indurating twigs and suborbicular leaves, which are cuneate into a petiole and crenate-dentate.

Seed of *De Winter & Verdoorn* 9009 germinated in Pretoria. One plant survived and grew to 60 cm tall, flowered profusely during June and July 1970 and was visited by swarms of bees.

Specimens which appear to be a form of this species have larger, glabrescent leaves and they occur west of the escarpment but not in regions with an annual precipitation below 100 mm and thus not near the coast. The following appear to belong to this form or are possibly hybrids nearest *H. desertorum*:

S.W.A.—Lüderitz South, Farm Spitskop, Merxmüller & Giess 28714; Zebrafontein, Merxmüller & Giess 28787.

CAPE.—Namaqualand: between Steinkopf and Port Nolloth, Rösch & Le Roux 1177; S.W. of Kuboos, Lavranos 11030. Vanrhynsdorp: S. of town, Thompson 2107. Garies: Garies, Esterhuysen 5309 (BOL).

64. *Hermannia pfeilii* K. Schum. in Notizbl. bot. Gart. Mus. Berl. 2: 304 (1899). Type: Cape, between Port Nolloth and Oakup, Pfeil 34 (Z!).

H. patellicalyx Engl. in Bot. Jb. 55: 358 (1919); M. Friedrich et al. in F.S.W.A. 84: 19 (1969). Type: South West Africa; Tafelberg near Buntfeldschuh, Schäfer 501 sub Marloth 5244 (PRE!).

Suffrutex, much branched, 20–80 cm tall, leaf-scars prominent; branchlets thinly grey-tomentose (tomentum of fringed, minute scales and stellate hairs), glabrescent, indurating and spiky but usually not sharp-pointed. *Stipules* from semi-obovate to deltoid or subulate, falling by a clean cut at base or, if persisting, becoming woody and brittle, 1–3 mm long, finely stellate-pubescent. *Leaves* one or more at a node, very shortly petiolate; blade obovate to obovate-cuneate, often broader at apex than long, 4–15 mm long, 5–12 mm broad at apex, entire or obtusely 3- or more-lobed at apex, concolorous, sometimes conduplicate, grey-tomentose on both surfaces, tomentum of fringed, minute, pitted scales; petiole 0,5–5 mm long. *Inflorescence* of few-flowered, racemose

cymes terminal on ultimate branchlets, flowers secund; peduncle usually indistinguishable or up to 3 mm long; bracts and bracteoles from ovate to deltoid or subulate, 1–3 mm long, rather thick; pedicels 2–6 mm long, thinly tomentose as on branchlets. *Calyx* patelliform, subinflated, 5-angled, from densely to sparsely finely stellate hairy without, lobed to almost middle, lobes erect, broadly triangular, sinuses wide. *Petals* bright yellow, about 10 mm long, blade more or less ovate, narrowed abruptly into a section with broad, incurved margins and below that into a spur which is usually curved. *Stamens* with broad, hyaline, obovate filaments about 3,5 mm long, apparently glabrous on the shoulders; anthers ciliate, about 3,5 mm long, overlapping the filaments for 1 mm. *Ovary* about 2,5 mm long, obscurely 5-lobed, finely stellate-tomentose, hairs slightly longer at the apex; stipe 0,5 mm long; styles cohering, about 4,5 mm long, shortly exserted, shortly and patently pubescent; stigmas capitate. *Capsule* about 5 mm long, stellate-pubescent, obtusely 5-lobed, lobes rounded at apex.

Found along the west coast of Namaqualand from Kleinsee, just north of Buffels River, northwards to the Namib as far as the Lüderitz area.

CAPE.—Namaqualand: near Kleinsee, Verdoorn 1871; Port Nolloth, Galpin & Pearson 7573; 7518; near Alexander Bay, Werger 507; E. of Oppenheimer Bridge, Orange River Mouth, Leistner 3437; Grootderm, Lavranos 11013; Anenous Pass, Rösch 2167.

S.W.A.—Lüderitz: Bogenfels, Schäfer sub Marloth 5244; Klinghardsgebirge, Dinter 3882; 4057; Pomona, Dinter 6348; Haalenberg, Dinter 3804.

This species approaches *H. cuneifolia* in several respects, especially in the cuneate, concolorous leaves with more or less the same pubescence. Microscopically the tomentum on both sides is made up of fringed, pitted scales. In *H. cuneifolia* the scales are larger than in our species. The most striking difference is in the calyx; in *H. cuneifolia* it is campanulate, not at all inflated, and shortly lobed, while in *H. pfeilii* it is, as the synonym *H. patellicalyx* implies, shaped like a little dish and subinflated with lobes almost as long as the disc. *H. pfeilii* is also close to *H. desertorum* but differs mainly in the larger flowers and the leaves which are more constantly obovate-cuneate, rather thick in texture and very shallowly, if at all, crenate. The areas of distribution are adjacent but distinct. *H. pfeilii* is restricted to the coastal area.

The scrap of the type gathering of *H. pfeilii* in Z, a twig with a small leaf and a loose, normal-sized leaf, together with the description, leaves one in no doubt that *H. pfeilii* is synonymous with *H. patellicalyx*.

65. *Hermannia multiflora* Jacq., Hort. Schoenbr. 1, t.128 (1797); Reichb., Ic. Descr. Pl. Cult. t.69 (1823); DC., Prodr. 1: 495 (1824). Type: Cape, Cult. Hort. Schoenbr., right hand specimen annotated by Jacquin (W, lecto!; PRE, photo!).

H. cuneifolia sensu Harv. in F.C. 1: 189, partly.

Suffrutex, about 30–75 cm tall, bushy, much branched, outer branches spreading-ascending; branchlets lepidote-stellate, the new growth densely so. *Stipules* with lower lanceolate-subulate, about 2 mm long, the upper ovate-acuminate, about 3 mm long, 1 mm broad at base. *Leaves* petiolate, sometimes appearing fascicled when crowded on abbreviated lateral shoots; blade discolorous, usually oblong-cuneate, sometimes suborbicular-cuneate, variable in size, from about 3 mm long and 1,5 mm broad near apex, to 20 mm long and 11 mm broad, rounded at apex, crenate-dentate in upper portion, dark and finely

lepidote-stellate on upper surface, pale lepidote-stellate-tomentose beneath, midrib and subflabellate nerves impressed above and prominent beneath; petiole 1,5–5 mm long. *Inflorescence* of 1–2-flowered cymes arranged in fairly lax, terminal, racemose cymes, one to two at each node of raceme; peduncles straight, erect or suberect, varying in length, lower short, the terminal long, from about 5–20 mm long; pedicels usually shorter and slightly cernuous; bracts and bracteoles variable, ovate to lanceolate-acuminate, up to 5 at a node, often with an elliptic, entire, petioled bract up to 9 mm long and 1 mm broad among them. *Flowers* yellow to orange-yellow, sweetly scented, about 8 mm long (rarely 5 mm long). *Calyx* broadly campanulate to subpatelliform, about 5 mm long, lobed to about midway, fawn to brown-tomentose, the lepidote-stellate pubescence dense, the scales reddish brown and hairs straw-coloured resulting in a mousey colour. *Petals* 5–10 mm long, suborbicular to oblong-orbicular in upper half, narrowing into a short waist and produced below into a claw with inrolled margins, waist and claw densely to sparsely but obviously stellate-pubescent on margins. *Stamens* with filaments cohering at base of stipe; filaments hyaline, obovate-cuneate, pubescent on shoulders; anthers ciliate, slightly shorter than filaments which they shortly overlap at base. *Ovary* densely lepidote-stellate, the hairs long and erect at apex, shallowly 5-lobed, shortly stipitate; styles cohering, erect, about 2,5 mm long. *Capsule* densely lepidote-stellate, about 4 mm long, shallowly 5-lobed, withering calyx and stamens persisting at base.

Found on rocky slopes, in mountain Fynbos, on level sandy plateaux and on hills above the Atlantic coast. Recorded from the Peninsula northwards to Vanrhynsdorp and Calvinia.

CAPE.—Bellville: Visser's Hok, Leighton 1798. Caledon: Dwarsberg, Stokoe in SAM 61160. Calvinia: Lokenburg, Leistner 338; Acocks 17052. Clanwilliam: Olifants River Bergen, Schlechter 5080; Blaauw Berg, Schlechter 8438. Malmesbury: Mamre, Van Niekerk 655; Hopefield, Compton 15967 (NBG). Paarl: Klappmuts, Erik Wall s.n. (S); near Wellington, Grant 2232. Peninsula: Cape Town, Prior s.n.; Marloth 1558; Hutchinson 167; Claremont, Schlechter 1512; Cape Flats, Rehmann 2192 (Z); Witsands, Esterhuysen 12960; Simonstown, Taylor 3708; Muizenberg, Bolus 308 (SAM, BOL). Piketberg: Elands Kloof, Hafström & Acocks 933. Stellenbosch: Stellenbosch, Bos 304. Tulbagh: Saron Flats, Wiese 16 (NBG). Van Rhynsdorp: Giftberg, Leopoldt 3986; N. of Graafwater, Taylor 3941. Worcester: Orchard, Hex River Valley, Esterhuysen 10299.

This species is characterized by the dense, lepidote-stellate tomentum on the calyx. It was described and figured by Jacquin in Hortus Schoenbrunnensis. The excellent painting makes it possible to match specimens with it and there are numerous representatives in many herbaria. Unfortunately, through a misidentification by Harvey, they are named *Hermannia cuneifolia*. In the Flora Capensis, Harvey writes that he cannot distinguish *H. multiflora* from *H. cuneifolia* by any tangible characters. *H. cuneifolia* is figured on t.124 of Hortus Schoenbrunnensis. With the adequate material that is available today these species can be readily distinguished. The principle diagnostic characters are that in *H. multiflora* the leaves are discolorous with rounded apices and prominent, subflabellate nerves beneath and the flowers are disposed in cymose panicles with acuminate bracts whereas the leaves in *H. cuneifolia* are the same colour on both surfaces, with a silvery hue, truncate or emarginate at the apex and the nerves seldom prominent. The flowers are secondly arranged on short, cernuous pedicels and the bracts are broadly ovate and abruptly acute but not acuminate.

The areas of distribution of the two species meet, but do not overlap.

Among the *Hermannia* specimens in W, a specimen was found with the name *Hermannia multiflora* written on the label in Jacquin's hand. This has all the diagnostic features of the figured plant and is thus selected as the type specimen.

H. multiflora is very variable in habit and crosses readily, but the dense, mousey or brownish lepidote-stellate tomentum on the calyx appears to be a dominant feature, as are the cuneate leaves, which are whitish tomentose on the lower surface. One of the three bracteoles, the central one, sometimes elongates and is narrowly elliptic or lanceolate and acuminate.

A form with small flowers and slender twigs, known only from Pakhuis Pass, is represented in some herbaria (e.g. *Compton* 9620; *Esterhuysen* 3367 and *Acocks* 15036). It has the diagnostic features of *H. multiflora* and is here treated as a form or hybrid of that species. While superficially resembling *H. helicoidea* it differs in the pubescence on the calyx, the type of inflorescence and the stipules.

In some herbaria specimens of *H. multiflora* have been named *H. triphylla* Cav., that is "sensu Cav.", as the type of *H. triphylla* L. is a species of *Lotononis*. With regard to *H. triphylla* sensu Cav., Diss. 333, t. 178, fig. 3, De Winter observed that *H. Bolus* 308 compares well with Thunberg's specimen in UPS named *H. triphylla* by Cavanilles. *H. Bolus* 308 in PRE, Z, SAM & BOL is *H. multiflora* Jacq.

66. *Hermannia alnifolia* L., Sp. Pl. ed. 1: 674 (1753); Cav., Diss. t. 179 fig. 1 (1788). Curtis's bot. Mag. 9: t. 299 (1795); Jacq., Hort. Schoenbr. 3: 291 (1798); DC., Prodr. 1: 495 (1824); Eckl. & Zeyh., Enum. 46: 364 (1834); Harv. in F.C. 1: 189 (1860); Adamson in Adamson & Salter, Fl. Cap. Penins. 585 (1950). Type: Cape, ex Hort. Cliff., Linn. Herb. Cat. No. 854.5 (BM, lecto.; PRE, photo.!).

Suffrutex, varying from prostrate to semi-erect, occasionally scrambling, usually about 40 cm tall but varying from 30 cm to 2 m, branchlets stellate-pubescent, hairs up to 0.5 mm long, stellate hairs often raised on tubercles (occasional specimens with long hairs may be hybrids). *Stipules* narrowly to broadly ovate, rounded or deeply cordate at base, sometimes auricled, lobes (auricles) decurrent on branchlets, usually abruptly narrowed into a cuspidate or caudate apex, finely stellate-tomentose. *Leaves* subrotund or broadly oblong, cuneate at base, rarely ovate, 3–25 mm long, 2.5–18 mm broad, finely stellate-tomentose on both surfaces, lower white-tomentose, nerves on lower surface subplicate, prominent, margins crenate, sometimes with a bristle ± 5 mm long on each rounded lobe; petiole 1–5 mm long, stellate-pubescent. *Inflorescence* of racemose or sometimes paniculate cymes, ultimate cymes 2–3-flowered; branches stellate-tomentose; pedicels usually of unequal length, 1–4.5 mm long; bracts on main branchlets of inflorescence mostly ovate-acuminate, sometimes with caudate apex, cordate at base, lobes sometimes decurrent, about 3 mm long (rarely a long, oblanceolate bract up to 4.5 mm), bracts at base of cymes smaller and usually deeply 3-lobed, about 1.5 mm long. *Calyx* campanulate, usually with wide sinuses between subulate teeth, 3–4 mm long, teeth about 1.5 mm long, texture rather thin, sparsely to fairly densely stellate-pubescent without, hairs remaining especially along the 5 main veins. *Petals* yellow to orange, about 3–6 mm long, more or less oblong,

broadly rounded at apex narrowing towards the centre, lower third with inrolled margins, abruptly narrowed into a short 0.5 mm long claw, inrolled margins obscurely ciliate or with sparse stellate hairs near margin. *Stamens* with hyaline filaments, obovate-oblong, about 2.5 mm long, with a few hairs on shoulders; anthers about 2 mm long, cells acute at apex, ciliate in lower half. *Ovary* 5-lobed, densely stellate-pubescent, becoming glabrous in part, lobes rounded at apex; style about 5 mm long, arising from centre of lobes, minutely and sparsely hairy in part. *Capsule* usually enclosed by the calyx and corolla remains, about 3.5 mm long and 4 mm broad, fairly shallowly 5-lobed apices of lobes rounded, not much produced above level of style-base. *Seeds* reniform or variously compressed, minutely papillose (scaly?) becoming very obscure, ± 1 mm diam.

Occurs on stony hills, low lying loamy places and Coastal Renosterveld. Recorded from George and Oudtshoorn in the east westwards to the Peninsula and then northwards to Clanwilliam, and rare in Namaqualand (see *Salter* 1511 in MO.).

CAPE.—Bredasdorp: Bredasdorp, *Esterhuysen* 3073; Kathoek, *Taylor* 3783. Caledon: Caledon *Story* 3071. Ceres: Gydo Pass, *Hafström* & *Acocks* 936; near White Bridge, *Van Breda* 779. Clanwilliam: Pakhuis, *Esterhuysen* 3367; near Clanwilliam, *Schlechter* 5067. George: east of Mossel Bay, *Acocks* 15385. Heidelberg: Heidelberg, *Acocks* 21392. Malmesbury: Darling, *Esterhuysen* 12974. Montagu: Montagu Baths, *Page* 132; Bushmans Vlei, *Pica Survey* 576. Mossel Bay: between George and Mossel Bay, *Sidey* 1728. Paarl: Paarl, *Hutchinson* 456; between Paarlberg and Paardeberg, *Drège* (S). Peninsula: Sea Point, *Smith* 2934; near Cape Town, *Marloth* 1749; Vissers Hok, *Esterhuysen* 9984. Piketberg: Porterville, *Wilman* 720; Pikenierskloof, *Penther* 2089 (S). Riversdale: Soetmek River, *Acocks* 21374; Gouritz Riv., *Schlechter* 5712. Robertson: Wansbek, *Van Breda* & *Joubert* 1986. Stellenbosch: near Berg River, *Zwartland*, *Zeyher* 1985 (3 specimens); Welgevallen, *Taylor* 5020. Swellendam: Swellendam, *Acocks* 14591, Bontebok Park, *Liebenberg* 6449; 6426; Stormsvalley, *Drège* 1987 (S). Tulbagh: hills, *Marloth* 7128. Wellington: Wellington, *Thomson* 15. Worcester: Bainskloof, *Leighton* 1987; Stettyn, *Van Rensburg* 180; Stettynsberg, *Esterhuysen* 15594; Veld Reserve, *Van Breda* 24.

Three not clearly defined groups can be recognized, (1) a fairly robust, suberect to erect form with normal internodes, (2) a form with more or less the same habit but with short internodes, and (3) a prostrate form with flowers rather smaller and petals only slightly longer than the calyx. All three these forms are represented in LINN: the typical form by Cat. No. 854.5, the form with short internodes by 854.6 and the prostrate form with short petals by 854.7. All forms are characterized by numerous small flowers, suborbicular cuneate leaves which are stellate-tomentose on both surfaces, the lower usually whitish tomentose, and the rather thin calyx which is usually laxly stellate-pubescent, with the stellate hairs occurring mainly on the nerves.

Ecklon & *Zeyher* Enum. No. 363, named *H. multiflora* in S and LE, is *H. alnifolia* L.

67. *Hermannia muricata* Eckl. & Zeyh., Enum. 43, No. 343 (1834). Type: Cape, "Zwellendam", *Ecklon* & *Zeyher* Enum. No. 343 (S!; PRE, photo.!). SAM!).

Mahernia dryadiphylla Eckl. & Zeyh., Enum. 51, No. 400 (1834). Type: Cape, Clanwilliam, Brakfontein, *Ecklon* & *Zeyher* Enum. No. 400 (TCD; PRE, photo.!). S!; PRE!; W!; LE!; SAM!).

Hermannia dryadiphylla (Eckl. & Zeyh.) Harv. in F.C. 1: 191 (1860) as "*dryadifolia*".

H. dryadiphylla (Eckl. & Zeyh.) Druce in Rep. bot Soc. Exch. Cl. Br. Isl., 627 (1917), comb. superfl.

Suffrutex, much branched from base; branches rather slender, outer arcuate-ascending usually with

long (over 0,5 mm), tubercle-based bristles, one or more from each tubercle, occasionally short, gland-tipped hairs present as well, sometimes (in more northerly and south-eastern plants) the tubercle-based bristles are displaced by a stellate-pubescent and minute fringed or stellate scales. *Stipules* narrowly to broadly ovate, rounded or cordate at base, often broad, oblique, amplexicaul or decurrent at base, acuminate to abruptly acuminate at apex. *Leaves* petiolate; blade narrowly oblong, 8–36 mm long, 2–10 mm broad, rounded at base, sometimes slightly narrowing towards rounded base and broadest near apex, margins sinuate-crenate to sinuate-dentate, slightly recurved, upper surface sparsely hairy with long tubercle-based hairs or sometimes subdensely stellate-pubescent with hairs short, nerves impressed, lower surface whitish tomentose, but thinly so on the prominent nerves; petiole 2–10 mm long, rarely up to 15 mm long. *Inflorescence* of long, interrupted, paniculate cymes, terminal on branchlets; peduncles and pedicels slender, 10–30 mm long, pubescent as on branchlets; bracts opposite, broadly ovate, cordate, abruptly acuminate, 3–5 mm long, 1,5–3 mm broad at base; bracteoles up to 3 at base of pedicels, narrowly ovate, lanceolate with acuminate apex or subulate, 1,5–3,5 mm long, 0,75–1,5 mm broad. *Calyx* flask-shaped, narrow at base, pubescence as on inflorescence and branchlets, glabrescent, about 5 mm long, lobed to above middle, lobes sparsely ciliate or densely and softly so in the eastern form, sinuses fairly wide. *Petals* "bright orange-yellow or orange-red", about 7 mm long, suborbicular in upper half, narrowed below into a claw with infolded margins, glabrous in specimens dissected. *Stamens* about 6 mm long, cohering at base around stipe; filaments hyaline, oblong-cuneate, minutely and sparsely pubescent on shoulders; anthers ciliate, overlapping the filaments at base. *Ovary* shallowly 5-lobed, stellate-pubescent on the sinuses, about 2 mm long, stipe 1 mm long; styles cohering, 4 mm long. *Capsule* shallowly 5-lobed, stellate-pubescent along sutures, minutely so between sutures, glabrescent, faded calyx persisting at base and obscuring stipe.

Found on hills and mountain slopes in river valleys. Recorded from Namaqualand southwards to the Clanwilliam and Worcester Districts (especially in the Hex, Krom and Olifants river valleys) then eastward to the George, Uniondale and Steyterville Districts.

CAPE.—Clanwilliam: Brakfontein, *Ecklon & Zeyher* Enum. No. 400; Olifants River, *L. Bolus* 20328 (BOL); S. of Citrusdal, *De Winter & Verdoorn* 9056; *Schlieben* 12440, George: W.N.W. of Camfer Station, *Esterhuysen* 16790 (BOL); Zebra, *Compton* 24420. Laingsburg: Fissantekraal Valley, *Compton* 21118 (NBG). Namaqualand: *Scully* 198 (BOL); Skilpad, *Barker* 8621 (NBG); Kamieskroon, *Esterhuysen* 23602. Piketberg: Porterville, *Edwards* 188 (Z) and in BOL 28060. Steyterville: W. of Wilgehof, *Oliver* 4572. Swellendam: Swellendam, *Ecklon & Zeyher* Enum. No. 343 (S). Uniondale: Kromme River Heights, *Fourcade* 2698 (BOL); Mannejesberg, *Oliver* 3600. Worcester: Hex River near De Doorns, *H. Bolus* 8007; Tweedside, *Marloth* 10802 (BOL); *Mauve & I. Oliver* 211.

This species is characterized by the narrowly oblong leaf-blade sometimes narrowing slightly towards the base, but with the base rounded, not cuneate into the petiole, the white-tomentose undersurface and the sinuate-crenate, slightly recurved margins which form a narrow dark rim around the undersurface, by the long, lax, terminal paniculate cymes with long slender peduncles and pedicels, and the usually broad-based stipules and bracts. A fourth characteristic, found on the types and other specimens from the western Cape, namely the tubercle-based, long, bristle-like hairs borne laxly on most parts of

the plant, seems to be replaced in specimens from northerly (Namaqualand) and more easterly regions by a denser stellate pubescence of short hairs (character displacement?).

H. muricata is close to the not very well known species *H. repetenda*, which is a more erect plant with usually broader, obovate or broadly oblong-ovate leaves cuneate in the lower third, not narrowly oblong and narrowed towards the rounded base as in *H. muricata*.

As in other species, a small-flowered twiggy form of *H. muricata* occurs occasionally. Examples are: Khamieskroon, *Esterhuysen* 23602 (BOL); Pakhuis Pass, *Esterhuysen* 21935 (BOL) and Khamiesberg, *Pearson* 6159 (SAM).

68. *Hermannia repetenda* Verdoorn in Bothalia 10: 77 (1969). Type: Cape, Cult. Hort. Hannov., *Schrader* s.n., (GOET., lecto.!, PRE, photo.!).

H. hirsuta Schrad. in Schrad. & Wendl., Sert. Hannov. 10, t. 4 (1795); Willd., Sp. Pl. 3: 594 (1800); Reichb., Ic. Descr. Pl. Cult. t. 59, fig. 2 (1822); DC., Prodr. 1: 495 (1824); F.C. 1: 190 (1860), excl. syn., non Mill. (1768). Type: as above.

Suffrutex, erect, virgate, laxly branched above, ultimate branchlets ending in an inflorescence which often turns slightly aside with a younger branchlet developing below and overtopping it, sparsely pubescent with minute stellate hairs, sometimes with short, gland-tipped hairs intermingled, often also subsparingly hirsute with long, pointed, patent hairs about 1–1,5 mm long arising singly or 2 or more from a bulbous base, apparently caducous or readily broken off. *Stipules* acuminate to abruptly acuminate, \pm 5–12 mm long, base broad to subcordate sometimes very oblique and subamplexicaul, pubescence as on branchlets but sometimes denser. *Leaves* petiolate; blade fairly narrowly to broadly oblong, oblong-obovate or oblong-ovate, cuneate in lower third, 15–40 mm long, 7–20 mm broad, crenate except at cuneate base, 3-nerved at base, nerves impressed above, prominent beneath, subflabellately branched, upper surface finely stellate-pubescent and minutely papillose and usually sparsely to densely pilose with long, pointed hairs, undersurface usually, at least when young, whitish tomentose with fine stellate pubescence; petiole 3–15 mm long, pubescent. *Inflorescence* terminal, of lax, paniculate cymes; bracts 2- or 3-nate, occasionally the third a long, subulate bract, otherwise like stipules varying from \pm 5 mm long and acuminate from a fairly broad base, to 14 mm long and abruptly acuminate from a broad, oblique subcordate, decurrent base; peduncles and pedicels with pubescence as on branchlets. *Calyx* lobed to above middle, about 6 mm long, sinuses broad, texture thin, minutely stellate-pubescent, densely so at base (on cultivated plants?), sometimes long, bulbous-based hairs and short, gland-tipped hairs present. *Petals* about 7 mm long, narrowed about midway into a claw, blade suborbicular, claw with inrolled margins obscurely ciliate. *Stamens* about 4 mm long, with filaments cohering at base, hyaline, oblong-obovate, 2,5 mm long, about 1 mm broad near apex, sparsely stellate on shoulders, anthers 2 mm long, ciliate, overlapping filament at base. *Ovary* 5-lobed, stellate-pubescent especially along the sutures, rays short, but with longer bristle-like hairs at apex; stipe 0,5 mm. *Capsule* about 6 mm long, minutely and finely stellate-pubescent between sutures, more coarsely so on sutures.

Apparently extensively cultivated in the gardens of Europe in the late 18th and early 19th centuries.

Very rarely found in the wild today. Recorded from the Piketberg, Clanwilliam and Graaff-Reinet Districts.

CAPE.—Clanwilliam: Wupperthal, *Mauve* & *I. Oliver* 93; N.E. of Pakhuis, *Acocks* 15050. Graaff-Reinet: Ouberg Pass, *Oliver* 5197. Piketberg: Piketberg, *Hafström* & *Acocks* 929; Rest Mtn, *Gillet* 3731 (BOL); Elandsberg, *Pillans* 7952 (BOL).

In the past this species was confused with *H. aspera* Wendl., a very distinct species differing principally in the inflorescence which in *H. aspera* is a fairly short, paniculate cyme, terminal on the short, lateral branchlets. In addition, *H. aspera* has crowded, sessile leaves strongly crisped on the margins.

In some respects *H. repetenda* resembles *H. multiflora* but differs in the fine stellate pubescence or hispid hairs on the calyx in contrast to the dense, brownish, stellate tomentum on the calyces of *H. multiflorum*.

Another related species is *H. muricata* (see under that species for distinguishing features).

Although *H. repetenda* is well represented in European herbaria, the specimens having been made from plants cultivated in gardens, especially in the Herrenhausen garden, Hannover, but very few, widely distributed present day records exist. This is apparently one of the many *Hermannia* species which is heavily cropped by browsing animals.

H. repetenda is characterized by the inflorescence which is a long, lax, paniculate cyme, terminal on the ultimate branchlets but usually turning aside while a lower branch develops and overtops it.

When the new name for this species was published in Bothalia 10: 77 the locality "Van Ryns Pass" was given, based on *De Winter & Verdoorn* 9018 collected there. This specimen has since been found to be *H. rigida* and, to date, *H. repetenda* has not been recorded from that locality.

69. *Hermannia rigida* Harv. in F.C. 1: 188 (1860). Type: Namaqualand, *Zeyher* 112b (1126 sphalm.) (S, holo.!, PRE, photo.!).

H. oligantha Salter in JI S. Afr. Bot. 12: 99 (1946). Type: Cape, Clanwilliam District, 8 km east of Graafwater, *Salter* 2750 (BOL, holo.!).

Shrublet, rigid, fairly laxly branched, virgate, up to about 1 m tall; branchlets pubescent with fringed scales, hairs short, intermixed with fairly long hairs grouped on tubercled bases, minute gland-tipped hairs usually present as well, apical portion of branchlets persisting as dry slender twigs. *Stipules* narrowly to broadly ovate-acuminate, often broad-based and abruptly long-acuminate above, tomentose at least dorsally and occasionally long hairs present as well, 3–8 mm long, 1–3 mm broad near base, on old wood only prominent scars left. *Leaves* petiolate, at first clustered on undeveloped shoots; blade obovate, oblong-cuneate, ovate-cuneate or suborbicular in young leaves, 5–30 mm long, 5–12 mm broad, crenulate except on cuneate base, somewhat crisped or plaited, at first tomentose on both surfaces with fairly long appressed hairs, undersurface whitish, older leaves subglabrescent, nerves impressed above, prominent beneath, somewhat flabellate; petiole 2–10 mm long. *Inflorescence* of 1- to 3-flowered cymes, more usually 1-flowered, arranged in lax, terminal racemes; peduncle aborted or abbreviated; pedicels fairly stout, 5–9 mm long; bracts ovate-acuminate (like the stipules), about 5 mm long; bracteoles subulate to lanceolate-acuminate, 3–7 mm long.

Calyx finely stellate-pubescent especially at base, sometimes long hairs present as well, 5–7 mm long, lobed to above middle, sinuses wide. *Petals* bright yellow fading reddish, about 10 mm long, oblong above, narrowed into a claw with infolded margins, glabrous except for minute stellate pubescence on margins of infolded lower portion. *Stamens* with oblong-obovate, hyaline filaments about 4, 5 mm long, minutely and sparsely stellate on shoulders; anthers about 2, 5 mm long, ciliate, overlapping filaments for about 1 mm. *Ovary* about 2, 5 mm long, 5-lobed, densely stellate-pubescent on angles and with long erect hairs at apices; stipe 0, 75 mm long; styles about 4 mm long. *Capsule* 5–8 mm long with persistent calyx at base, 5-angled, 5-umbonate, finely stellate-pubescent to glabrescent between sutures, more coarsely so on angles and at apex.

Found on rocky ridges, at the base of sandstone boulders, in red sandy soil, or in shale. Recorded from the Clanwilliam and Calvinia Districts and from Namaqualand.

CAPE.—Calvinia: upper part of Van Ryn's Pass, *De Winter & Verdoorn* 9018; *Ellis* & *Schlieben* 12464. Clanwilliam: Nardouw road, *Compton* 22822 (NBG); Pakhuis Pass, *De Winter & Verdoorn* 9044; *Oliver* in STE 33288. Namaqualand: Namaqualand, *Zeyher* 112b (in F.C. 1126 sphalm.); W. slopes of Kamiesberg, *Acocks* 19517 (leaves mostly young and suborbicular); S.E. of Kamieskroon, *Compton* 11106 (NBG); N. of Kamieskroon, *Anegas*, *Pearson* 6275 (SAM).

Characterized by the terminal pseudo-racemes of 1–3-flowered (mostly 1-flowered) cymes in which the peduncles are usually aborted or abbreviated and the pedicels stout and rigid.

Before seeing the type specimen kindly sent on loan from Herb. S, it was thought that *De Winter & Verdoorn* 9018 and 9044 could fall in the range of *H. repetenda*, but more material of both these species has shown them to be distinct. Among other details, the lax racemose cymes of *H. rigida* with aborted peduncles clearly differ from the paniculate cymes of *H. repetenda* with long, slender peduncles and pedicels.

Having studied the type specimen of *H. rigida*, it was found too that *H. oligantha* is that species. Of the five cited specimens the type, *Salter* 2750 (BOL) is not very typical being more twiggy with all leaves young and suborbicular but it falls within the range of variation of the species and includes the diagnostic inflorescence. The same applies to *Pillans* 7093 (BOL). The other three are typical *H. rigida*: *Schlechter* 8384 (fragment in BOL). *Pearson* 6275 (SAM) and *Compton* 11106 (NBG).

70. *Hermannia helicoidea* Verdoorn in Bothalia 11: 288 (1974). Type: Cape, Clanwilliam, Hex River valley, *Pillans* 9063 (PRE, holo.!, BOL!).

Suffrutex, much branched; branches slender, young branchlets pubescent with minute, fringed or stellate scales and occasionally with a few tufted hairs on a tubercled base, older glabrescent. *Stipules* broad, amplexicaul and decurrent at the base, rounded at apex with a mucro or abruptly attenuate with a cuspidate or caudate apex, sometimes shallowly 3-lobed, margins obscurely crenate or dentate, finely and densely stellate on upper surface, hairs short, whitish stellate-tomentose below, glabrescent, 1, 5–4 mm long, 2–6 mm broad at base. *Leaves* petiolate; blade narrowly to broadly oblong-cuneate, 3–10 mm long, rarely longer, 2–6, 5 mm broad in upper half, finely and densely stellate on upper surface, whitish stellate-tomentose below, margins somewhat irregularly crenate as well as undulate;

petiole 1–3 mm long. *Inflorescence* axillary or terminal on lateral branchlets, cymes scorpioid, usually curved in a helicoid fashion, with very slender, sparsely and minutely stellate-pubescent branches; peduncles up to 25 mm long; pedicels 1.5 mm long; bracts and bracteoles like the stipules but smaller, about 2 mm long, some appearing subulate from a broad base. *Calyx* campanulate, finely stellate-pubescent (hairs very short), about 4 mm long, 5-lobed to above middle, sinuses wide. *Petals* about 6.5 mm long, more or less orbicular in upper half, narrowed below into a claw with infolded margins. *Stamens* about 4 mm long with obovate-oblong, hyaline filaments which are overlapped by anther bases. *Capsule* about 4 mm long, stellate-pubescent, somewhat 5-lobed, calyx persistent at base.

Found on hills or mountain slopes in river valleys. Recorded from the Clanwilliam District in the Hex and Olifants river valleys.

CAPE.—Clanwilliam: without precise locality, *Stokoe* s.n.; hills in the Hex River valley, *Pillans* 9063; Olifants River valley, *Schlechter* 5092; north of Citrusdal, *L. E. Taylor* 1025 (MO).

Characterized by the monochasial, helicoid development of the slender, lateral cymes. In herbaria these specimens were mostly named *H. rigida*, which is a species of taller, more rigid and robust shrublets with inflorescences of short, 1- to 3-flowered cymes, more usually 1-flowered, arranged in lax terminal racemes, the peduncles usually absorbed and the pedicels fairly stout and rigid.

H. helicoidea resembles *H. muricata* superficially, but differs from it in leaf-shape and pubescence and in the inflorescence which is both terminal and axillary, and usually distinctly helicoid.

In *H. muricata* the leaves are narrowly oblong, rounded at the base and the margin sinuate-crenate to sinuate-dentate with the upper surface usually sparsely hairy with long tubercle-based hairs, rarely stellate-pubescent.

71. *Hermannia aspera* Wendl., Bot. Beobacht. 52 (1798). Type: Cult. Hort. Herrenh., type specimen not traced (see notes).

H. scabra sensu Jacq., Hort. Schoenbr. t. 127 (1797), as to figure, and excluding syn. *H. hirsuta* Schrad. (sphalm. Cav.); Willd., Sp. Pl. 3: 594 (1800), partly as to citation Jacq. t. 127 and “(aspera) Wendl. Obs. 52”; sensu DC., Prodr. 1: 495 (1824) as to syn. and citation Jacq. t. 127; sensu Reichb., Ic. Descr. Pl. 1, t. 59, fig. 1 (1822); sensu Eckl. & Zeyh., Enum. 44, No. 350 (1834), non Cav.

Shrub, stem single, erect, 40 cm–2 m tall, more or less rigid, ultimate branchlets short, fairly stout, very rough with tubercle-based, tufted bristles (long or short, 2 to many). *Stipules* about 1.7–7 mm long, rounded to broadly cordate at usually oblique base, decurrent on one side, abruptly narrowed into a linear-acute to subulate apical portion. *Leaves* sessile or subsessile, crowded, 1 or more at a node, different sizes at a node, size of leaf varies considerably on different plants too; blade oblong-cuneate, 5–30 mm long, 1–20 mm broad, rounded, subtruncate, lobed or emarginate at apex, rarely apiculate, broadly cuneate at base, incurved and crenate and crisped on margins, upper surface minutely papillose and scaly stellate-pubescent or with tubercle-based hairs, lower surface finely white stellate-tomentose between the veins and sparsely stellate on veins; midrib and about 3 suberect lateral veins prominent beneath; petiole 0–4 mm long. *Inflorescence* terminal on ultimate branchlets of simple or paniculate cymes, short, up to 30 mm long,

3 to 15-flowered; bracts like stipules but smaller, 2, 3 or 4 at a node; pedicels 4–8 mm long. *Calyx* submembranous with strong nerves, 5–6 mm long, lobed almost to middle, glabrescent except along nerves which are sparsely pubescent with bulbous-based hairs, lobes sometimes rather densely ciliate with soft hairs and hairy on inner face. *Petals* yellow turning red, 6–9 mm long, 4 mm broad in upper half, narrowed just below middle into a claw, margins of claw fairly broadly infolded. *Stamens* cohering or joined at base, free portion about 5 mm long; filaments hyaline, oblong-cuneate, obscurely hairy on shoulders; anthers pointed, ciliate. *Ovary* stellate-pubescent, shortly stipitate; styles about 3.5 mm long. *Capsule* small, 4–5 mm long, subglobose, densely stellate-pubescent (hairs longer towards apex), 5-umbonate.

Found in arid Fynbos, Karroid scrub and Renoster-veld in the south-western Cape. Recorded from Worcester northwards to Namaqualand (Kamiesberg) and through Swellendam and Montagu to Ladismith in the east.

CAPE.—Calvinia: Lokenberg, *Acocks* 17025; Botterkloof Pass, *Middlemost* 1609 (NBG). Ceres: On road between Koue Bokkeveld and Cedarberg, N. of farm Excelsior, *Taylor* 5900; N. of Pienaarskloof, *Acocks* 23689; Clanwilliam: Pakhuis Pass, *De Winter & Verdoorn* 9041; *Pillans* 7089 (BOL). Ladismith: Anysberg, *Esterhuysen* 17075; 25975 (BOL). Montagu: Kiesiesberg, *Lewis* in SAM 59090 (SAM); Baden, *Pillans* 7924. Namaqualand: Kamiesberg, *Coppejans* 1108 (STE). Gifberg, *Phillips* 7381 (SAM). Swellendam: Anysberg, *Stokoe* 8222 (NBG & BOL). Vanrhynsdorp: Bokkeveld Mts, *Marloth* 7580; Gifberg Pass, *Acocks* 14878. Worcester: Hex River, *H. Bolus* 11864.

This species is plentiful over the area of its distribution and is well represented in most herbaria, due, probably to its roughness and woodiness which renders it unpalatable to browsing animals. It is distinguished from others with somewhat similar leaves (having the lower surface finely white stellate-tomentose) in that the leaves are sessile or subsessile and crowded. Judging from specimens in the Leningrad and Vienna herbaria this species flourished for several years, at the turn of the 18th Century, in the botanic gardens of Europe. To date it has been wrongly identified in all herbaria as either *H. scabra* or *H. hirsuta*. Jacquin in Vienna published an excellent painting of this characteristic plant, in his Hortus Schoenbrunnensis, under the name *H. scabra* Cav., a wrong identification, for *H. scabra* Cav. is a distinct species (see note under that species). This mistake was subsequently recognized by several botanists, who then referred to it by the homonym *H. scabra* Jacq. A specimen of our species in the Leningrad Herbarium, of which there is a photograph in Pretoria (PRE Neg. No. 4576), is labelled *Hermannia scabra* Jacq. and in the same handwriting *H. aspera* Wendl. is given as a synonym. This led to the investigation of Wendland's name which was found to be the correct one for this species with sessile leaves. Unfortunately no type specimen has been traced to date, but the Leningrad specimen mentioned above was collected and labelled in the gardens of Göttingen at a time when Wendland was associated with that University and so may be looked upon as an authentic representative of his species.

The use of the name *H. hirsuta* stems from the mistaken conclusion that Wendland's species, *H. aspera*, was the same as that described by Schradler (1795) as *H. hirsuta*, now named *H. repetenda* (see notes under *H. repetenda*). This species differs from *H. aspera*, among other things, in the longer and laxer inflorescence and the petioled leaves. It is not so densely leafy nor as rigidly woody and roughly pubescent and therefore more palatable. This may

account for its scarcity in comparison with *H. aspera*, in the veld as well as in herbaria.

Certain specimens collected in the Montagu District, where *H. disticha* occurs, appear to be a form or hybrid of *H. aspera* which is also recorded in parts of the district. The specimens are *De Winter* & *Verdoorn* 9088, *Compton* 18359 (NBG) and 18416 (NBG), *Lewis* in SAM 59089 (SAM), *Walgate* in BOL 23457 (BOL) and *Walgate* in BOL 23458 (BOL). All but the last do not have persistent white tomentum on the lower surface and so resemble *H. disticha*, and in all specimens the margin of the leaf is not so markedly recurved as in more typical *H. aspera*. All these are robust luxuriant plants and this suggests that they might be hybrids between *H. aspera* and *H. disticha* but nearest to *H. aspera*.

72. *Hermannia conglomerata* Eckl. & Zeyh., Enum. 44, No. 352 (1834); Harv. in F.C. 1: 194 (1860); Saund. Rep. Bot. 4: t. 217 (1871). Type: Cape, Uitenhage, "Sondags et Zwartkops Rivier", *Ecklon & Zeyher*, Enum. No. 352 (K; PRE, photo. !; PRE !; SAM !; LE !).

H. glomerata E. Mey. in Drège, Zwei Pfl. Doc. 191 (1843), nomen.

Suffrutex, suberect, with ascending branches, 10–60 cm tall, branchlets pubescent with long tubercle-based, few-rayed stellate hairs, with age hairs fall off and branchlets are rough with scattered tubercles. *Stipules* narrowly to broadly ovate-acuminate, cordate at base, about 8 mm long, with long, few-rayed stellate hairs. *Leaves* petiolate; blade subrotund, 1–2 cm diam., pubescent with long, few-rayed, stellate hairs, sparse and 1- to 2-rayed on upper surface, several-rayed and more copious on lower surface, margin crenate; petiole about 5 mm long. *Inflorescence* of sessile cymes crowded at ends of branches and branchlets, interspersed with leaves and bracts; bracts ovate-, or broadly lanceolate-acuminate, about 9 mm long and 3,5 mm broad near base; bracteoles linear-lanceolate, about 7 mm long and 1 mm broad near base. *Calyx* 6 mm long, 5-lobed to about midway, densely hispid, at least when young, with few-rayed, long, tubercle-based hairs. *Petals* about as long as calyx, strongly contorted and shortly exerted from the glabrous, more or less oblong calyx tube, obovate, rounded at apex, narrowing slightly at centre, lower half with margins narrowly inrolled and narrowing at base to a short claw. *Stamens* about 4 mm long; filaments hyaline, \pm linear, narrowing towards base, glabrous in the specimens dissected, overlapped by anther bases; anthers shortly ciliate. *Ovary* about 2 mm long, 5-lobed, hirsute with long erect hairs.

Among karroid scrub on hillsides in dry river valleys. Recorded from Alexandria, Albany, Uitenhage and Riversdale (Fish River, Sundays River and Wyders River).

CAPE.—Albany: N.W. of Grahamstown, Fish River valley, *Acocks* 18397; *Schlechter* 6113. Alexandria: Addo Bush near Kinkelbosch, *Story* 2729. Port Elizabeth: Cape Recife, *Zeyher* 1990. Riversdale: Wyders River, *Muir* 978. Uitenhage: Sundays River, "Sondags and Zwartkoprivier", *Ecklon & Zeyher* Enum. 352.

A sheet with five specimens of this species in the Bentham Herbarium was photographed by *De Winter*. The specimens are labelled as follows: (1 & 2) *Drège* 1838, no locality, (3) *Schlechter* 6113, Fish River (4) *Cooper* 1995, western districts and (5) *Cooper* 2012, Natal. There is probably some mistake about the last mentioned locality. No Natal record exists. *Cooper* 2012 with the same label is in Z.

The species is characterized by the long spreading hairs, especially conspicuous on the young flowers and the glomerate inflorescence.

Drège 7268 and 7292, cited in *Zwei Documente* from Zuurberg as *A. glomerata*, are this species.

73. *Hermannia micrantha* Adamson in J1 S. Afr. Bot. 10: 123 (1944); Fl. Cap. Penins. 585 (1950). Type: Cape, Little Lion's Head, *Salter* sub *Adamson* 1901 (BOL!).

H. intricata Adamson in J1 S. Afr. Bot. 7: 198 (1941), non Engl. (1919). Type: as above.

Suffrutex small, usually less than 30 cm tall, much branched; branches slender, divaricate, roughly stellate-pubescent with rays often over 0,5 mm long, and with short, gland-tipped hairs intermingled. *Stipules* usually in pairs, ovate, acute, cordate or rounded at base, oblique, one side deeply cordate, 2–3 mm long, 1–1,5 mm broad, coarsely stellate-pubescent, scaly and occasionally with gland-tipped hairs intermingled. *Leaves* petiolate; blade light green on both surfaces, not whitish beneath, obovate-oblong, narrowing slightly at base, about 6–10 mm long, 3–8 mm broad, rarely larger, stellate-pubescent and scaly on both surfaces, and sometimes with minute gland-tipped hairs intermingled, margins crenate; petiole 2–5 mm long. *Inflorescence* of 1- to 2-flowered cymes, terminal or laxly racemose on slender ultimate twigs; peduncles vary in length, often 1 cm long; pedicels 1–2,5 mm long, stellate-pubescent and with minute gland-tipped hairs; bracts like stipules ovate-cordate, those at base of ultimate cyme usually smaller and 3-lobed. *Calyx* about 3 mm long, 5-lobed to the centre or slightly beyond, stellate-pubescent without, and with minute gland-tipped hairs intermixed, teeth about 1,5 mm long, acute. *Petals* lemon-yellow, about 5 mm long, more or less oblong, rounded at apex, narrowing slightly to middle with lower portion with inrolled margins, hardly clawed at base. *Stamens* 3,5 mm long, with broad, obovate-oblong filaments with a few hairs on shoulders; anthers 1,5 mm long, cells acute at apex, ciliate on margins. *Ovary* and style about 3 mm long; ovary stellate-pubescent with long bristles at apex; styles with a few short, sparse hairs. *Capsule* about 4 mm long and 4 mm broad, deeply 5-lobed, lobes keeled and apices projecting above by about one third, stellate-pubescent, especially on keels, with some rays over 0,5 mm long.

Found on dry southern and western slopes of Table Mountain, on or in the vicinity of Little Lion's Head.

CAPE.—Peninsula: Little Lion's Head, *Salter* sub *Adamson* 1901 (BOL); *Adamson* 2618; Table Mt., foot of cliffs at west end, *Esterhuysen* 19251; lower west slopes, *Pillans* 4264 (BOL).

This species is close to *H. alnifolia* but is distinguished by the leaves being green on both sides, obovate and broadly cuneate at the base and not suborbicular, the stellate pubescence coarser and interspersed with minute gland-tipped hairs. The capsule is more deeply 5-lobed with the apices longer (only different in degree).

In the Bolus Herbarium, the type specimen has the number 7417 added in pencil after *Salter's* name.

74. *Hermannia disticha* Schrad. in Schrad. & Wendl., Sert. Hannov. 26, t. 16 (1795–97); Reichb. Ic. Descr. Pl. Cult., t. 60 (1882); Harv. in F.C. 1: 188 (1860). Type: In herb Vahl, missit Schrader (C, lecto.; PRE, photo.!).

H. rotundifolia Jacq., Hort. Schoenbr. 63, t. 118 (1797).

Shrublet, erect, branched, 50–90 cm high; branchlets with long, tubercle-based, spreading hairs. *Stipules* deltoid to broadly ovate, acuminate, usually with a broad, cordate base, which is somewhat decurrent on the branch or stem, with single or few-rayed bulbous-based hairs, especially on dentate margin. *Leaves* distichously arranged, shortly petiolate; blade broadly ovate-oblong to obovate-oblong, 10×8–20×16 mm or sometimes longer, broadly cuneate or rounded at base, upper surface with long, bulbous-based hairs, which are single or few-rayed, lower surface with similar hairs but many-rayed or stellate from a bulbous base, at first densely so giving a whitish appearance to undersurface; margin distinctly crenate-dentate; petiole very short or 2–5 mm long. *Inflorescence* a few-flowered, fairly short, racemose or paniculate cyme terminal on ultimate branchlets; pedicels short or up to 5 mm long, pubescence as on branchlets; bracts lanceolate-acuminate to ovate-acuminate up to 6 mm long, the upper small and lobed, sparsely pubescent with long, bulbous-based hairs. *Calyx* 5-lobed to about middle, about 5 mm long, sparsely pubescent with long stellate hairs from a tubercled or scale-like base. *Petals* more or less oblong, about 7 mm long, abruptly narrowed about midway, upper half suborbicular, lower half with broadly infolded margins, obscurely ciliate and pubescent, narrowing at base into a claw about 1,5 mm long. *Stamens* with hyaline filaments which are oblong, slightly narrowing towards base, about 3 mm long, with a few hairs on shoulders; anthers about 3 mm long, cells pointed, ciliate along sutures. *Ovary* somewhat 5-angled, pubescent (hairs erect and long at apex), very shortly stipitate, stipe about 0,5 mm long; styles minutely pubescent, about 3,5 mm long. *Capsule* enclosed in the \pm persistent calyx and corolla, about 2,5×2,5 mm, 5-lobed, 5-umbonate at apex, stellate-pubescent, hairs long in upper half and at apex. *Seed* reniform, suborbicular, tubercled, \pm 1 mm diam.

Recorded to date only from the rocky kloofs in the mountains of Montagu.

CAPE.—Montagu: Kloof near Montagu Baths, Page 25; *De Winter & Verdoorn* 9083; *Kogmanskloof*, *Acocks* 20347; *Kleurkloof*, *Compton* 5749 (NBG).

Characterized by the pubescence of long, patent, bulbous-based hairs, the broad, distichous leaves which are not persistently whitish pubescent on the lower surface and the short, \pm 4 cm long inflorescences.

On the labels in several herbaria the authors are given as "Schröd. & Wendl.", but in the original description and in the *Index Kewensis* Wendlan's name does not appear.

75. *Hermannia decipiens* E. Mey. ex Harv. in F.C. 1: 192 (1860); Phillips in Ann. S. Afr. Mus. 9: 337 (1917); E. Mey. in *Drège*, *Zwei Pfl. Doc.* 191 (1843), nomen. Syntypes: Cape, Zwartberge, Klaarstroom *Drège* s.n. (S!; W!; Z!; LE!); Vrolyk, *Drège* 7277 (LE!).

Suffrutex up to 1,30 m tall, branches pubescent with tufted or stellate hairs from a scaly base or on small raised tubercles, hairs long or sometimes short and dense. *Stipules* deciduous, lanceolate-acuminate to subulate, 4–6 mm long, up to 2 mm broad at base, stellate-pubescent, hairs long or short. *Leaves* sessile or subsessile, sometimes erect, imbricating, oblong, oblong-elliptic or oblong cuneate, 7–18 mm long, 4–7 mm broad, apex acute, rounded and mucronate or

truncate and lobed, densely but roughly stellate on both surfaces, sometimes thickly tomentose, hairs long or short, mostly yellowish; petiole 0–1 mm long. *Inflorescence* a short, few-flowered, simple or branched cyme, terminal or in axils of upper leaves of branchlets; pedicels 2–5 mm long; bracts subulate, 2–7 mm long, seldom reaching more than basal third of calyx. *Calyx* not inflated, campanulate, densely and coarsely pubescent with stellate and tufted hairs, hairs golden yellow, tube 4–6 mm long, lobes about 2 mm long, deltoid, acute. *Petals* 7–8 mm long, oblong in upper half, narrowed abruptly into a claw with inrolled margins, dorsally conspicuously stellate from lower portion of upper half almost to base of claw. *Stamens* about 4 mm long with broad hyaline filaments about 3 mm long; anthers ciliate, about 2 mm long. *Ovary* 2 mm long, 1,5 mm broad, 5-lobed, stellate-pubescent; styles 4 mm long, hairy at base; stigmasca pitate. *Capsule* enclosed by perianth, shortly exerted from calyx, about 5 mm long, subglobose, 5-lobed, stellate-pubescent; stipe short, up to 1 mm long.

Found in mountainous country from the Ladismith area along the Swartberg eastwards to Willowmore.

CAPE.—Ladismith: Seven Weeks Poort, *Marloth* 2978; *Phillips* 1400. Ladismith–Laingsburg: "Zwartberge, Klaarstroom, *Drège* s.n. Vrolyk, *Drège* 7277 (LE) Vleiland, *Acocks* 20497. Willowmore: Swanepoelspoortberg, *Marloth* 4127.

This species is closely related to *H. involucrata* having the same type of pubescence and leaf-shape and the same non-inflated calyx which is densely stellate-pubescent with yellow hairs. It differs from that species in the smaller leaves and flowers and the leaves being more erect and fairly closely appressed to the stem.

76. *Hermannia involucrata* Cav., Diss. 328, t. 177, fig. 1. (1788). Type: Cape, *Thunberg* s.n. in Herb. Cav., (MA, holo.; PRE, photo.). (The specimen so named in the Thunberg herbarium (UPS, herb. No. 15484), does not agree, having an inflated calyx, but the one named "*H. salviifolia*" (*Thunberg* s.n. in UPS, herb no. 15492) appears to be this species.

H. chrysophylla Eckl. & Zeyh., Enum. 44, No. 346 (1834), pro parte, as to some specimens with non-inflated calices but labelled with Enum. No. 346 (PRE!; LE!; W!).

H. salviifolia sensu Cav., Diss. 328, t. 180, fig. 2, non Linn. f.

Suffrutex 60 cm to 1,3 m high, erect or straggling, branchlets with shiny, tufted hairs from a sessile, scaly base or a slightly raised tubercle, hairs long or short and give the new growth, leaves and calyx a golden hue. *Stipules* narrowly lanceolate, acuminate, subulate or linear-acute, 2,5–10 mm long, base 0,5–1,5 mm broad, roughly and subclaxly to densely stellate, incurved in upper portion. *Leaves* subsessile to shortly petiolate; blade strikingly variable in shape from broadly elliptic to elliptic or oblong-obovate, 10–37 mm long, 6–14 mm broad, acute and mucronate to broadly rounded and mucronate or broadest and toothed at subtruncate apex, roughly and subdensely or densely stellate-pubescent on both surfaces, hairs stiff and golden yellow, scattered among groups of hairs are minute, dark pustules; petiole 1–5 mm long. *Inflorescence* of short, few-flowered, branched cymes in axils of upper leaves, up to 2,5 cm long; peduncles short, up to 5 mm long, roughly stellate; bracts at base of pedicels subulate, up to 10 mm long, often reaching to top of calyx, roughly stellate, arcuate in upper portion; pedicels 1–2 mm long, roughly stellate. *Calyx* subcoriaceous with strong ribs, densely pubescent with stellate or tufted hairs from a scaly base, hairs shiny and giving calyx a golden hue, about 8 mm long, lobed in upper third or almost to middle,

tube cup-shaped, lobes cuspidate from a deltoid base. *Petals* yellow, about 10 mm long, oblong in upper half, narrowed into a claw with inrolled margins, apex rounded to subtruncate, recurved, dorsally finely stellate-pubescent in lower two-thirds. *Stamens* about 4–6 mm long with hyaline, obovate-oblong filaments; anthers about 2.5 mm long, ciliate. *Ovary* 5-angled, stellate at least on sutures; stipe 0.5–1 mm long; styles about 4 mm long. *Capsule* about 7 mm long, half exserted from persistent calyx, finely stellate-pubescent between sutures which are coarsely stellate-pubescent.

Found in gorges, kloofs and on mountain slopes in false Fynbos. Recorded from Ladismith, Uniondale and Willowmore eastwards to Uitenhage.

CAPE.—Humansdorp: Combrink, *Acocks* 13698. Steytlerville: Waaiport, *Acocks* 16014. Uitenhage: Kantiens River, *Oliver* 1360; Melkhoutboom, *Long* 1387; "Langekloof & Winterhoek" *Ecklon & Zeyher* Enum. No. 346 (PRE; SAM; LE; W). Uniondale: Prince Alfred's Pass, *Acocks* 21116. Willowmore: Baviaanskloof, *Oliver* 4563.

Differs from the closely related and variable species *H. salviifolia* in that the calyx is not diaphanous nor urceolate. Characterized by the tufted, shiny hairs which give the vegetative parts a golden yellow hue, the subcoriaceous, strongly ribbed, thickly stellate-pubescent calyx and the petals which are dorsally, finely stellate-pubescent. Among the tufted hairs on the leaves and calyx are scattered minute pustules or glands that give the appearance of minute holes. This feature is shown very clearly as black dots on the plate in Cav., Diss. The leaves vary considerably in shape, occurring in at least two distinct shapes. The bracts are usually half as long to longer than the calyx.

In some specimens, e.g. *Dahlgren & Peterson* 26 and *Acocks* 16014, the pubescence is denser and shorter but still typical of the majority of specimens. This may be due to some foreign influence, but the main diagnostic characters are present.

77. *Hermannia pillansii* *Compton* in Trans. R. Soc. S. Afr. 19: 300 (1931). Type: Cape, Witteberg, Laingsburg Dist., *Compton* 2797 (BOL, lecto.!, K; PRE, photo.!).

Suffrutex, low, branching from base, young branches densely stellate-hirsute. *Stipules* narrowly to broadly ovate, acuminate, broad ones abruptly acuminate at apex and cordate at base, 4–6 mm long, 1–4 mm broad at base, densely stellate-pubescent. *Leaves* sessile, obovate-cuneate, up to 10 mm long, 5 mm broad near apex, crenate except on cuneate base, densely stellate-pubescent to tomentose on both surfaces with hairs both short and long. *Inflorescence* of 1- to 2-flowered cymes clustered at apices of ultimate branchlets; peduncles 4–8 mm long; pedicels short, 2–4 mm long; bracteoles narrowly ovate-acuminate, up to 6 mm long. *Calyx* 5 mm long, lobed to almost midway, densely stellate-hispid, hairs rather long, light yellow. *Petals* about 7 mm long, more or less oblong in upper third, narrowed into a densely ciliate waist and produced below into a claw with infolded margins. *Stamens* 4.5 mm long; filaments narrowly obovate, not or only slightly broader than anthers, hyaline, overlapped by anther bases, anthers 2 mm long, ciliate. *Ovary* subglobose, shallowly 5-lobed, 3 mm long whitish stellate-tomentose; stipe 0.5 mm long; styles 4 mm long. *Capsule* about 4 mm long, enclosed in the calyx, thinly whitish tomentose.

Found on mountains at 1 300 m or higher. Recorded from the Witteberg in the Laingsburg District.

CAPE.—Laingsburg: Wittebergen, *Compton* 2797 (BOL; K); 3159 (BOL); 12215 (NBG); foothills, *Marloth* 11424.

This species closely resembles *H. stipulacea*, but can be distinguished mainly by the leaves and stipules being densely and persistently pubescent on both surfaces instead of the very characteristic lax and distinct pubescence on those of *H. stipulacea*. In addition, the shape of the leaf is obovate-cuneate in *H. pillansii* and the flowers clustered in terminal cymes with rather short peduncles and pedicels.

Of the four syntypes, *Compton* 2797, 3159, 3299 and 3559, *Compton* 2797 is here selected as type because there is a duplicate of this specimen in K.

78. *Hermannia stipulacea* *Lehm. ex Eckl. & Zeyh.*, Enum. 44, No. 349 (1834); Harv. in F.C. 1: 192 (1860). Type: Cape, near mouth of the "Zwartkops" River, *Ecklon & Zeyher* Enum. No. 349 (K; PRE, photo.!, PRE!; W!; SAM!).

Suffrutex, erect or sprawling with ascending branches, branches laxly, rarely subdensely, stellate-pubescent, hairs few and long, rarely short from a scaly base. *Stipules* leaf-like, about half the size of leaves or over half, ovate-acuminate to ovate-lanceolate, cordate at base, from 3.5–11 mm long, 1–7 mm broad near base, laxly and distinctly stellate-pubescent. *Leaves* sessile or shortly petiolate, sometimes erect and somewhat imbricate; blade oblong, oblong-cuneate, sometimes narrowly so, 4–16 mm long, 2–6 mm broad, apex acute, rounded to broadly rounded or subtruncate, usually broadest near the apex which is often lobed, base rounded, laxly but distinctly and strongly stellate on both surfaces, hairs long; petiole up to 2 mm long. *Inflorescence* of 1- to 2-flowered cymes in axils of upper leaves and at the apices of the branchlets; peduncle from 3–20 mm long; pedicels 1–7 mm long; bracts usually 3, 1 long and 2 shorter (the much reduced leaf and 2 stipules), ovate, lanceolate or subulate, 1.5–6 mm long, 0.5–3 mm broad, stellate-pubescent as on leaves, at least along margins. *Calyx* about 6.5 mm long, lobed almost to middle, densely yellow scaly-tomentose and stellate-hispid, hairs long, lobes about 3 mm long, deltoid-acute. *Petals* about 9.5 mm long, subglobose in upper third, narrowed into a densely ciliate waist and produced into a claw with infolded margins. *Stamens* about 6 mm long, filaments hyaline, oblong-cuneate, ciliate on shoulders, overlapped by anther bases; anthers 3 mm long, acute, ciliate. *Ovary* oblong, about 2 mm long, shallowly 5-lobed, subglabrous or shortly stellate below, densely stellate at the apex of each locule, hairs long; stipe 0.5 mm. *Capsule* shortly exserted from persistent calyx, about 6 mm long, stellate-hairy.

Found in Coastal Renosterveld, on stony mountain slopes, in Fynbos and burnt patches. Recorded from Riversdale and Ladismith and eastwards to Port Elizabeth.

CAPE.—Humansdorp: Onzer, *Drège* 7276 (W); *Marsh* 1351. Ladismith: Buffels Kloof, *Esterhuysen* 13998. Montagu: between Scheepersrust and Barrydale, *Esterhuysen* 24603 (BOL). Mossel Bay: Cloete's Pass, *Acocks* 14636. Oudtshoorn: Meiring's Poort, *Esterhuysen* 24868 (BOL). Port Elizabeth: near "Zwartkops River" mouth, *Ecklon & Zeyher* Enum. No. 349. Riversdale: Soetmelks River, *Acocks* 22359; Onverwacht, *Muir* 1607. Uniondale: Noll's Halt, *Acocks* 16035; near Joubertina, *Thompson* 952; Die Hoek, *Esterhuysen* 10582.

Characterized by the leaf-like stipules and the sublux, stellate pubescence with stiff hairs. The densely lepidote-stellate calyx resembles the calyx of *H. involucrata* Cav. which has the same golden yellow hue.

Harvey cites a Drège specimen from the Orange River. This must be a mistake, for the Orange River is far outside the known area of distribution.

H. pillansii is closely allied to this species, but differs in the pubescence on the leaf (see under that species). Also, the hairs on the calyx are a lighter yellow, not so golden, and the stipules more acutely acuminate.

H. latifolia sensu Eckl. & Zeyh., Enum. 348 (non Jacq.) in SAM is *H. stipulacea* Lehm. ex Eckl. & Zeyh.

79. *Hermannia filifolia* L.f., Suppl. 302 (1781). Type: Cape, Thunberg s.n., Herb. No. 15473 (UPS, holo.; PRE, photo.!).

Suffrutex, straggling, with slender branchlets or erect and robust, often heavily browsed. *Stipules* leaf-like, somewhat shorter or longer and usually flatter than leaves. *Leaves* sessile, fascicled, at first crowded on abbreviated shoots, glabrescent, filiform to subulate, sulcate (ericoid), sometimes appearing narrowly linear or linear-spathulate on pressed specimens, firmly fleshy or succulent and glaucous, 4–20 mm long, apex acute or mucronate, not lobed, fascicles distant or crowded. *Inflorescence* of 1- or more-flowered cymes in axils of upper leaves and at apices of branchlets in racemose cymes. *Calyx* 4–6 (–10) mm, finely stellate-pubescent or rough with minute scales or tubercles. *Petals* strongly twisted, usually dark red, blade oblong, abruptly narrowed just below middle into a claw which is pubescent on edges. *Stamens* with more or less linear-oblong, hyaline filaments. *Capsule* from 6–12 mm long, 5-umbonate at apex, finely stellate-pubescent between sutures, more coarsely so on sutures and at apex. Fig. 1.2.

Key to varieties

- Leaves short, 4–15 mm long, or up to 20 mm long in var. *grandicalyx* but then much reduced towards the apices of flowering branchlets and there shorter than internodes:
 Calyx 4–6 mm long, leaves firm, internodes rough with minute scales or tubercles.....var. *filifolia*
 Calyx about 10 mm long, markedly paler than petals, leaves sometimes succulent and glaucous, long internodes rarely minutely scaly, usually glabrescent and shiny.....var. *grandicalyx*
 Leaves long, up to 20 mm long and not much reduced towards apices of flowering branches, usually longer than internodes.....var. *robusta*

(a) var. *filifolia*

Verdoorn in Bothalia 10: 572 (1972).

Hermannia filifolia L. f., Suppl. 302 (1781); Cav., Diss. t. 180, fig. 3 (1788); Jacq., Hort. Schoenbr. t. 123 (1797); DC., Prodr. 1: 495 (1824); Eckl. & Zeyh., Enum. 47, No. 372 (1824), partly; Harv. in F.C. 1: 195 (1860). Type: as above.

H. passerinaeformis Eckl. & Zeyh., Enum. 47, No. 373 (1824). Type: Cape, Swellendam, Ecklon & Zeyher Enum. No. 373 (K; PRE, photo!, SAM!; W!; S!).

H. gilfillanii N.E. Br. in Kew Bull. 1906: 100 (1906). Type: Cape, Middelburg, Conway Farm, *Gilfillan* sub *Galpin* 5506 K, holo.; PRE, photo.!(PRE!).

H. filifolia var. *passerinoide* Harv. (sic) in F.C. 1: 195 (1860). Syntypes: Cape, Swellendam, Ecklon & Zeyher Enum. No. 373; between Ecksteen and Stormvally, Zeyher 2008 (S!).

Straggling plant with thin branchlets and small flowers 4–6 mm long borne in axils of upper leaf-clusters and in racemose cymes at apices of branchlets. Farther east in the Great Karroo bushes are a degree more robust and somewhat larger flowers are usually clustered only at apices of branchlets. The branchlets are rough with minute scales or tubercles. The specific epithet “*filifolia*” refers to the most diagnostic feature of species, the more or less subulate or

ericoid leaves, which however sometimes appear narrowly linear to spathulate on pressed specimens. *Leaves* clustered, sessile, about 4–15 mm long, glabrous or minutely scaly pubescent, acute at apex, sometimes ending in a single hair or subobtuse and mucronate. *Stipules* almost indistinguishable from leaves but a close examination shows stipules to be narrowly linear rather than subulate and usually with a broader base. *Calyx* usually about 5 or 6 mm long, finely stellate-pubescent or in some areas rough with minute scales or tubercles as in the related *H. flammea*. *Capsule* about 6 mm long.

Found on mountain slopes, in passes, on rocky hills, and sandstone ridges. Recorded from Worcester, Ceres and Swellendam in the Little Karoo and in the Great Karoo from Aberdeen, Graaff-Reinet and Cradock northwards to the Orange River, and just beyond to Bethulie in the Orange Free State.

CAPE.—Albert: Byrnavon, 50 km W. of Aliwal North, Werger 1111. Ceres: N. of Pienaarskloof, *Acocks* 23772. Cradock: Jakkalsfontein, *Acocks* 17505. Graaff-Reinet: Farm Rietvlei, *Galpin* 995; Farm Klipfontein, *Codd* 3529. Middelburg: Conway Farm, *Gilfillan* sub *Galpin* 5506; N. of Grootfontein, *Van Zinderen Bakker* 1100; N. of Middelburg, *Sidey* 476. Swellendam: near Barrydale, *Acocks* 20353; National Bontebok Park, *Barnard* 649. Venterstad: Oviston Reserve, *Van Schoor* ORFS-27; *Fourie* ORFS-11. Worcester: near De Doorns, *Bolus* 13077; Pienaarskloof, *Taylor* 6494.

O.F.S.—Bethulie: Tussen Riviere Game Reserve, *Roberts* 5511.

Occasional specimens have been found in some of the localities recorded for this variety which appear to be intermediates or hybrids.

(b) var. *grandicalyx* Verdoorn in Bothalia 10: 572 (1972). Type: Cape, Prince Albert, N. of Prince Albert Road, *Acocks* 17098 (PRE, holo.!).

H. linifolia sensu Eckl. & Zeyh., Enum. 371 (1834); sensu Harv. in F.C. 1: 195 (1860), non Burm. f.

The diagnostic feature of this variety is the large calyx, about as long as, and much paler than the usually dark red petals, being pale pink or more often cream-coloured, finely stellate-pubescent and lobed to just beyond the middle, lobes long-acuminate to apex. The fascicled leaves appear linear to linear-spathulate and plicate on pressed specimens but are described as subterete, sometimes firm in texture but often succulent and glaucous. Shoots from heavily browsed plants are characterized by having long, usually glabrous and shiny internodes and the flowers in fairly lax, terminal, racemose cymes. The capsule is larger than in the typical variety, up to 12 mm long.

Found along foothills, stony ridges and on steep shaly slopes or rocky outcrops. Recorded from the Little and Great Karoo, from Montagu eastwards through the northern areas of George to Steytlerville and northwards to Sutherland and Beaufort West.

CAPE.—Beaufort West: Vindragersfontein, *Acocks* 14328. George: Heimans River, *Oliver* 3575. Ladismith: about 10 km E. by S. of Ladismith, *Acocks* 14611; Laingsburg: Whitehill, *Compton* 11212 (NBG); about 18 km W. of Laingsburg, *Acocks* 24351. Montagu: Jakkalsfontein, *Van Breda* 1238. Prince Albert: about 5 km N. of Prince Albert Road Station, *Acocks* 17098. Riversdale: N. of Waterval (near Ladismith border), *Muir* 3754. Steytlerville: Mt. Pellier, *Oliver* 4578. Klein Roggeveld, *Marloth* 9584. Uniondale: between Hotspring and Toorwater, *Oliver* 3648.

H. linifolia sensu Harv. in F.C. fits this variety and the two specimens cited, *Drège* 7285 (LE; W.), and *Ecklon & Zeyher* Enum. No. 371 (L; S; W), belong here. *H. linifolia* Burm. f. (1768) is synonymous with *Hermannia scoparia* (Eckl. & Zeyh.) Harv. (1860). Harvey recognized that his concept of *H. linifolia* was nearly allied to *H. filifolia* and the many specimens

examined since have shown that it is merely a variety of that species.

(c) var. **robusta** Verdoorn in Bothalia 10: 572 (1972). Type: Cape, Port Elizabeth, Glendinning Vale, 2,4 km N.W. of Donkin Memorial, Olivier 458 (PRE, holo.).

H. filifolia sensu Eckl. & Zeyh., Enum. 47, No. 372 (1824), partly, as in BOL, non L.f.

This variety differs from the typical, principally in the longer, more crowded leaves, the usually larger flowers and the more robust plant. The plant can be up to 1 m tall and the branchlets are rough with minute scales or the tubercled bases of fallen hairs. The fascicled, ericoid leaves (appearing narrowly linear on pressed specimens) together with their leaf-like stipules are 10–20 mm long and are crowded on branches, usually longer than internodes and not much reduced towards the apices of the flowering branches. The flowers are somewhat larger than those of the typical variety but not quite as long as the majority of those of var. *grandicalyx*. From last-mentioned it can be distinguished mainly by calyx which is not quite as markedly paler than the petals and is rough with minute scales or tubercles, not finely stellate-pubescent.

To date found in disturbed areas and burnt patches in the Port Elizabeth and Uitenhage Districts.

CAPE.—Port Elizabeth: Glendinning Vale, 2,4 km N.W. of the Donkin Memorial, Olivier 458; 458a; Victoria Park, Long 792; Baakens River Valley, Galpin 9930; Patons Farm, Long 475; Eern Cliff, Galpin 6368. Uitenhage: Winterhoek Mountains, Fries, Nordlindh & Weimarck 1085; Groendal Wilderness area, Scharf 1018.

Ecklon & Zeyher Enum. No. 372 is obviously a mixed gathering, because of the two distinct localities mentioned and this is borne out by specimens in certain herbaria. In LE and BOL one of the specimens on the sheet with this label is var. *robusta* and must therefore be the Port Elizabeth gathering. On other sheets the specimens with this label are a form of var. *filifolia*. In S one of a mixture of specimens is var. *robusta* collected by Ecklon near the Lady Donkin Memorial. Specimen Zeyher 2004 in PRE is *H. filifolia* var. *robusta*, while in S it is *H. flammea*.

80. *Hermannia denudata* L.f., Suppl. 301 (1781). Type: Cape, Sparman in Linn. Herb. Cat. No. 854.10 (LINN, holo.; PRE, photo.).

Shrub virgate, 60 cm–2 m tall, vegetative parts totally glabrous or (var. *erecta*) at first rough with minute, fringed scales, occasionally intermixed with longer, fascicled hairs, glabrescent in parts. *Stipules* narrowly lanceolate-acuminate to ovate-acute, broad-based, sometimes oblique at base, from 3,5 to 17 mm long, 0,5 to 6 mm broad near base, several-nerved, glabrous or pubescent with fascicled hairs, sometimes glabrescent except on margins. *Leaves* shortly petiolate, suberect; blade of mature leaves (often many small leaves present on young shoots) lanceolate to more or less oblong, cuneate at base, coarsely dentate in upper half, from about 13 to 65 mm long, 5 to 14 mm broad, glabrous or with stellate or grouped hairs from a glandular base, glabrescent in part, apex acute, midrib prominent beneath; petiole 2–6 mm long. *Inflorescence* of 1- to 3-flowered cymes terminal and in axils of upper reduced leaves of ultimate branches; bracts like much reduced leaves and stipules, linear to subulate. *Calyx* glabrous or rough with minute, fringed scales, campanulate, about 4–6 mm long, 5-lobed to midway or almost midway.

Petals yellow to red and yellow, about 8 mm long, ovate-oblong in upper third, narrowed into a waist and produced below into a claw with inrolled margins. *Stamens* 4,5 to 5,5 mm long; filaments hyaline, obovate-cuneate, overlapped by anther bases. *Ovary* about 2,5 mm long, 5-angled, glabrous or stellate-tomentose. *Capsule* exerted from persistent calyx, up to 7 mm long, 5-angled with rounded umbos.

A distinct species, characterized by the virgate habit with more or less straight branches and suberect leaves which are distinctly but fairly laxly dentate in the upper half, the teeth more or less acute. The two varieties have restricted distributions, most surprisingly widely separated from each other.

Key to varieties

Vegetative parts entirely glabrous. Western Cape and Namaqualand.....(a) var. *denudata*
Vegetative parts rough with minute, fringed scales and tufted hairs from a glandular base, glabrescent in parts. Eastern Transvaal and Swaziland....(b) var. *erecta*

(a) var. *denudata*

H. denudata L.f., Suppl. 301 (1781); Cav., Diss. 6: 329, t. 181, fig. 1 (1788); Ait., Hort. Kew. ed. 1, 2: 415 (1789); Jacq., Hort. Schoenbr. 65, & 122 (1797); Reichb., Ic. Descr. Pl. Cult. t. 59 (1822); DC., Prodr. 1: 495 (1824); Harv. in F.C. 1: 194 (1860). Type: Cape, Sparman in Linnean Herb. Cat. No. 854.10 (LINN, holo.; PRE, photo.).

The typical variety is distinguished mainly in that the vegetative parts are completely glabrous, but there are a few differences of degree which as a rule cannot be regarded as specific. The stipules of var. *denudata* may reach a size of 17×6 mm although they are often smaller. The largest stipule seen on var. *erecta* was 9×3 mm, but the majority measured only 8×1,5 mm. The leaves on the typical variety are usually slightly longer in proportion to width, for example a leaf 40 mm long may be 8 to 10 mm broad in this variety while in var. *erecta* a leaf of 30 mm long is usually 9 or 10 mm broad. The flowers in var. *denudata* are recorded as yellow whereas in var. *erecta* they are often red or partly yellow and partly red.

Harvey l.c. cites *H. quercifolia* Eckl. & Zeyh., Enum. No. 383 as a synonym in part of *H. denudata*. It has not been possible to verify this.

Found in arid Fynbos in the Western Cape and Namaqualand. Recorded from Clanwilliam, Vanrhynsdorp, Calvinia and Namaqualand.

CAPE.—Calvinia: Boklanskloof, Lokenburg N., Acocks 19438; Ekerdam, Taylor 2747 (BOL). Clanwilliam: Cedarberg, Sanddrif, Taylor 7533; Nardouw, Stokoe 8224. Vanrhynsdorp: "Aties" (not located), Pearson in Percy Sladen Mem. Exped. 5387 (BOL); "Addies", Zeyher 115.

(b) var. *erecta* (N.E.Br.) B. Davy & Greenw. in Burt Davy, Fl. Transv. 1: 41 & 267 (1926). Type: Transvaal, Barberton, Galpin 1346 (K, holo.; PRE, photo.); PRE!).

H. erecta N.E. Br. in Kew Bull. 1897: 245 (1897).

Vegetative parts, including calyx, usually rough with minute, fringed scales plus grouped hairs from a glandular base, glabrescent in parts. *Stipules* 3,5×0,5 mm to 9×3 mm. The flowers are described as red, yellow or partly yellow and partly red.

Found on mountain tops, slopes, granite hillsides, in deep soil and semi-shade. Recorded from Lydenburg, Nelspruit, Barberton and across the border in Swaziland.

TRANSVAAL.—Barberton: Barberton, Bayliss BS/1535; Rogers 23867; Galpin 1346. Lydenburg: Erasmus Pass, Strey 3806. Nelspruit: E. of Nelspruit, Marais 275. Lowveld Botanic Garden, Buitendag 829; Nyamezane Bantu Trust, Nel 5; suburbs of Nelspruit, De Winter 9403.

SWAZILAND.—Mbabane: near Komati Bridge, *Compton* 28834.

81. *Hermannia flammea* Jacq., *Hort. Schoenbr.* 1: 69, t.129 (1797); Sims in *Curtis's bot. Mag.* 39: t.1349 (1811); DC., *Prodr.* 1: 495 (1824); Eckl. & Zeyh., *Enum.* 46, No. 367 (1834); Harv. in *F.C.* 1: 196 (1860). Type: Cape, Cult. Hort. Schoenbr. (W, lecto.; PRE, photo.).

H. falcata Eckl. & Zeyh., *Enum.* 46, No. 365 (1834). Type: Cape, Uitenhage, "Winterhoeks et Van Stadensrivierberge", *Ecklon & Zeyher*, *Enum.* No. 365 (PRE!; W!).

H. polymorpha Eckl. & Zeyh., *Enum.* 46, No. 366 (1834). Type: Eastern Cape, "Adow", "Zuurberge", "Zwartkopsrivier", "Karakamma" and Grahamstown, *Ecklon & Zeyher* *Enum.* No. 366 (PRE!; SAM!; W!).

H. orophila Eckl. & Zeyh., *Enum.* 47, No. 369 (1834); Harv. in *F.C.* 1: 191 (1860). Type: *Ecklon & Zeyher* No. 369 (PRE, lecto.; SAM!), not *Ecklon & Zeyher* *Enum.* No. 369 (S), see note.

Suffrutex up to about 65 cm tall, sometimes taller, erect or diffuse, with slender, usually suberect branchlets, branchlets sparsely to densely pubescent with minute, fringed scales or coarse, stellate hairs, pubescence usually densest on pedicels. *Stipules* usually linear-oblong to oblong, mucronate; sometimes obovate, usually erect but sometimes falcate, 4–11 mm long, 1–2 mm broad, stellate, glabrescent. *Leaves* usually fascicled, subsessile or very shortly petiolate; blade broadest at or near apex, cuneate, from 5–25 mm long, 3–10 mm broad, lowermost sometimes larger, apex rounded or subtruncate with a small, slightly recurved mucro and usually 2- to 6-toothed, stellate-hairy becoming glabrous, sometimes stellate hairs persistent but then leaves broad, sometimes persistent on margins only, leaves often rough with scaly bases of the stellate hairs; petiole up to 2 mm long. *Inflorescence* of 1- to 2-flowered cymes arranged in fairly lax, terminal, racemose cymes or clustered at apex of branchlets; peduncles 2–4 mm long; bracts subulate, linear or obovate, about 3 mm long; pedicels 2–3 mm long. *Calyx* lobed to about middle; lobes oblong-deltoid, base broad, very shortly and broadly acuminate to apex which is often incurved at first and then at least some spreading, rough with fairly laxly stellate hairs or with minute scales fringed with short hairs. *Petals* red or yellow, "yellow red-brown", "orange-red", "yellow inside, maroon outside", strongly twisted in upper half, 8–9 mm long, about 5 mm broad at broadly rounded apex, narrowing about midway into a rather broad claw with infolded margins, densely stellate-pubescent along the edges of lower half. *Filaments* hyaline, linear-oblong, somewhat cuneate, about 3 mm long; anthers about 2 mm long, ciliate, shortly overlapping filaments at base. *Ovary* about 6 mm long, stellate-pubescent. *Capsule* long exserted from persistent calyx, about 8 mm long, 5 mm broad, densely stellate-pubescent, 5-umbonate at the apex, umbos stellate.

Found on mountain slopes, stony hills and in valley bushveld. Recorded from western coastal Renosterbosveld, in the Somerset West, Stellenbosch and Paarl Districts, and, more commonly, in the southern coastal belt from Swellendam eastwards through Port Elizabeth and Albany to Kentani.

CAPE.—Albany: near Grahamstown, *Schlechter* 2637; Alocs, *Drege* 3005. Alexandria: *Galpin* 10758; near Nananga Store, *Story* 1310. Bathurst: Hopewell, *Acocks* 11073; Port Alfred, *Bayliss* 2640. East London: Nahoon River, *Galpin* 3286; *Smith* 3762. Humansdorp: *Thode* A711; The Glen, *Burt* *Davy* 12084. Kentani: coast, *Pegler* 37; Kei Mouth, *Flanagan* 198. King Williams Town: *Tyson* 843. Knysna: Knysna, *Keet* 672. Mosselbay: *Rogers* 22791. Paarl: Paardekop, *Drege* 7305. Port Elizabeth: slopes "Winterhoeks & Van Stadensrivierberge" *Ecklon & Zeyher* *Enum.* No. 365; Zuurberge near "Zwartkops-

rivier & Krakakamma", *Ecklon & Zeyher* *Enum.* No. 366; Zuurberg Sanatorium, *Long* 731; towards Wittekop, *Rodin* 1034. Riversdale: *H. Bolus* 11219. Somerset East: Zuurberg Hotel, *Story* 2383; near Annsville, *Story* 177. Stellenbosch: near Hottentottholland, *Ecklon & Zeyher* *Enum.* No. 399; Stellenbosch Mtn, *Bos* 133. Stutterheim; Commonage, *Acocks* 9536; *Rogers* 12715.

Characterized by the petals usually appearing darker than the calyx on dried specimens, and by the leaves being broadest at or near the apex with the majority toothed at the apex, usually long cuneate and subluxly pubescent with scales fringed with short hairs or coarse stellate hairs, usually glabrescent and rough with the bases of the hair-groups, or the stellate pubescence persisting on some broad-leaved forms or persisting on the margins only; calyx rough from the tubercled bases of the hairs, lobed to about midway, the lobes oblong-deltoid or deltoid from a broad base, often with the apical portion infolded at first and eventually at least some spreading. This feature gave rise to the description of the species *H. falcata*, now a synonym. The flowers are usually dark red, but a few yellow forms are recorded. Some specimens give the impression of being of hybrid origin. The leaves are usually in fascicles in the wild. The specimen figured in Hort. Schoenbr. and the pressed specimen in the Vienna herbarium show the leaves as not fascicled. This may be due to the plant being young. Other plants collected later in the same garden have fascicled leaves.

A specimen from the "Hortus Schoenbrunnensis" preserved in the National History Museum, Vienna, bearing the name *H. flammea*, agrees with Jacquin's description and plate and is therefore here selected as lectotype.

H. orophila Eckl. & Zeyh. is based on their No. 369, collected at "Hottentottholland" (Stellenbosch) and "Zwarteberg et Klynriviersberge" (Caledon). Judging by three specimens seen with this number, none of which has a specific locality, there are two distinct entities involved. Two specimens, one in PRE and the other in SAM, are obviously conspecific with *H. flammea*, having the dark petals, the characteristic pubescence on the calyx and the fringed scales on the branchlets. The third sheet, in S, is a smaller plant with petals obviously yellow and the branchlets very rough with tubercle-based hairs, matching *H. rudis*. In the description of *H. orophila*, the only item which points to one or other of the two entities is the phrase "Flores purpureo-violacei," which applies to the PRE and SAM specimens and not to the S specimen. As the PRE specimen is in better condition than the one in SAM, the former is selected as the lectotype, and *H. orophila* is included in synonymy under *H. flammea*.

82. *Hermannia flammula* Harv. in *F.C.* 1: 196 (1860). Type: Cape, Caledon, *Zeyher* 2009, (K, lecto; PRE, photo.; Z!; PRE!).

H. trifurca sensu Eckl. & Zeyh., *Enum.* 370, partly excl. Jacq. t. 125 (see Linnaea 19: 612 and fide Harvey, l.c. 196).

Suffrutex, erect, virgate, with slender branchlets leafy towards their apices, 25–60 cm tall, rarely 1 mm tall, branchlets pubescent with tubercle-based stellate hairs or fringed scales, intermixed with single, thin-walled, gland-tipped hairs. *Stipules* linear-oblong or very narrowly ovate-oblong, 2–8 mm long, 0.75–2 mm broad, stellate-pubescent with a few gland-tipped hairs intermixed. *Leaves* subsessile, petiole rarely up to 2.5 mm long; blade narrowly oblong-cuneate, usually folded, 7–15 mm long, rarely up to 22 mm long, 1.5–4 mm broad near apex, apex rounded,

mucronate or subtruncate and lobed, persistently stellate-pubescent on both sides, either coarsely so with hairs short or long, or densely so with long, thin-walled hairs (tomentose?), simple gland-tipped hairs usually intermixed. *Inflorescence* of 1- to 2-flowered cymes, one or two terminal on branchlets and appearing axillary when ultimate branchlets are very short; peduncles 1-4 cm long; pedicels unequal in a cyme, 2-8 mm long, densely and softly pubescent with gland-tipped hairs interspersed; bracts usually 3, linear to subulate, about 3,5 mm long and up to 0,5 mm broad, acute with a few erect hairs at apex. *Calyx* about 7 mm long, lobed to just beyond the middle, stellate-pubescent, densely and with more thin-walled hairs at the base, some hairs gland-tipped. *Petals* twisted, usually dark red, "claret red", "deep maroon", "deep port wine red", "creamy yellow in lower half", about 8 mm long, about 3,5 mm broad near the somewhat oblique apex, more or less oblong in upper third, then narrowed into a waist and produced into a claw with infolded margins and with stellate tomentum along sides. *Stamens* with hyaline, more or less narrowly oblong filaments which are somewhat longer than anthers and were glabrous in the specimens dissected, hooked at the point of attachment; anthers ciliate. *Ovary* densely stellate-pubescent, about 2,5 mm long; styles cohering about 2,75 mm long; stipe 0,75 mm long. *Capsule* 5-8 mm long, 5-umbonate at apex, stellate-pubescent especially along thickened sutures where stellate hairs are on tubercled bases.

Found on hill sides and mountain slopes to Coastal Renosterveld or Ngongoniveld. Recorded from Caledon District eastwards to George and, further inland, from Ladismith to Uniondale.

CAPE.—Bredasdorp: Klipdale, *Smith* 2584; 3198. Caledon: "Zwartberg", *Zeyher* 2009a; Caledon, *Compton* 14708. Ladismith: Roodeberg, *Esterhuysen* 17190. Mossel Bay: W. of Mossel Bay, *Acocks* 15397. Riversdale: E. of Heidelberg, *Acocks* 21101; Milkwoodfontein, *Galpin* 3789. Swellendam: Voormansbosch, *Zeyher* 2009b; Zuurbraak, *Acocks* 14081. Uniondale: Joubertina, *Van Breda* 1189; Buffelsrivier below Kammanasieberg, *Oliver* 3623.

Characterized by the persistently stellate-pubescent, small leaves, the mixed pubescence, some stellate hairs with thick walls (hard looking) but mostly thin-walled (soft looking) and single hairs with gland-tips intermingled, the flowers usually dark red (with pale calyx), cymes 1-, 2- or 3-flowered, terminal on the branchlets (some flowering branchlets very short).

83. *Hermannia joubertiana* Harv. in F.C. 1: 196 (1860). Type: Cape, Bredasdorp, Soetendalsvallei, *Joubert* s.n. (S-Herb. Sond., holo.; PRE, photo.!).

Suffrutex, 30-90 cm tall, spreading or bushy, branchlets pubescent with fringed scales or stellate-pubescent, stellate hairs mostly tubercle-based, glabrescent but small tubercles persistent. *Stipules* narrowly oblong to ovate-oblong, 2-5 mm long, 1,5-2 mm broad at base. *Leaves* sessile, up to about 12 mm long, narrowly cuneate or spatulate, entire except sometimes at apex, broadest near apex, about 2,5 mm broad, usually plicate, apex obtuse, mucronate, rarely lobed or toothed, abaxial surface usually pustulate and with minute stellate hairs usually crowning the pustules, glabrous on inner face, midrib broad (translucent?). *Inflorescence* of 2- to 3-flowered cymes, cymes clustered at apices of branchlets and sometimes in axils of upper leaves; peduncles short, up to about 2 mm long, bracts linear, 2 mm long; pedicels 2-5 mm long, erect and cernuous only at apex, stellate-pubescent, sometimes densely so and

with gland-tipped hairs interspersed. *Calyx* about 4 mm long, lobed to or almost to middle, tube at first narrowed at mouth but eventually wide and shallow, lobes acute from a deltoid base, sinuses wide, coarsely stellate-pubescent outside, sometimes gland-tipped hairs present as well, rarely glabrescent. *Petals* red, partly yellow within, "dark red", "bright red", or "dark purple", twisted, about 8 mm long, blade oblong, abruptly narrowed below middle into a claw with infolded margins, edges of claw thinly tomentose. *Stamens* about 4 mm long, anthers somewhat shorter than hyaline, more or less oblong filaments; filaments shortly overlapped by anther bases. *Ovary* about 2 mm long, shallowly 5-lobed and 5-umbonate at apex, stellate-hairy; stipe under 1 mm long; styles cohering, about 3 mm long; stigma capitate, usually conspicuous. *Capsule* about 4,5 mm long, stellate-hairy, bluntly 5-angled, 5-umbonate at apex; stipe 1 mm long, umbos 1 mm long.

Found on sandy flats and stabilized dunes in Coastal Fynbos. Recorded from Caledon through Bredasdorp to Mossel Bay.

CAPE.—Bredasdorp: S.W. of Bredasdorp, *Acocks* 15458; Caledon: Hermanus, *I. B. Walters* 282 (NBG). George: George, *Thorne* in SAM 51673 (SAM). Mossel Bay: N.E. of Mossel Bay, *Acocks* 15387. Riversdale: S. of Riversdale, *Acocks* 24097. Swellendam: Kleinfontein, between Brede and Duiwelshoek Riviere, *Zeyher* s.n. (SAM).

Characterized by the cuneate leaves usually folded and pustulate dorsally, sparsely stellate to glabrescent, hairs minute, apex mucronate, the average not toothed or lobed at the apex. The calyx is small and shallow with acute lobes and wide sinuses. Flowers usually red, small, petals about twice as long as the calyx.

84. *Hermannia scabra* Cav., Diss. 2, t. 182, fig. 2. (1788); DC., Prodr. 1: 495 (1824), partly excl. syn.; Harv. in F.C. 1: 191 (1860). Type: Cape, specimen in Herb. Lamarck s.n. (P, holo.; PRE, photo.!).

H. scordifolia sensu Eckl. & Zeyh., Enum. 43, No. 344 (1834).

H. denudata sensu Eckl. & Zeyh., Enum. 43, No. 345 l.c.

H. prestiana Turcz. in Byull. mosk. Obshch. 32, 1: 259 (1859). Type: Cape: "Paarlberg", *Zeyher* (sic) 7294 (for *Drège* 7294) (K; PRE, photo.!). PRE!; S! LE!, W!).

H. patula Harv. in F.C. 1: 187 (1860). Syntypes: Cape, mountain side near Tulbach, Ecklon & Zeyher Enum. No. 344 (S!); "Paarlberg", *Drège* 7294.

H. pedunculata Phill. in Ann. S. Afr. Mus. 9, 3: 114 (1913), non K. Schum. Syntypes: Cape, Vanrhynsdorp, Giftberg, *Phillips* 7377-7379 (SAM!).

Suffrutex, low spreading bush to stiffly erect shrublet up to 60 cm tall; branches fairly finely stellate-pubescent with intermingled gland-tipped hairs to sparsely and harshly stellate-pubescent, the hairs appressed or spreading, 1 to few from a basal tubercle. *Stipules* ovate to oblong-ovate from a broad base, sometimes obliquely cordate at base, 2-6 mm long, 1,5-3 mm broad at base, sparsely stellate-pubescent. *Leaves* shortly petiolate; blade cuneate from near apex or from midway, 2,5-40 mm long, varying in width from 2-15 mm broad at or near apex, lobed in upper half or at apex only, sparsely and harshly stellate-pubescent, hairs often 1 from the tubercled base, especially on the margins, glabrescent especially on upper surface which is finely dotted with minute tubercles or glands; petiole 1,5-5 mm long. *Inflorescence* of long, leafless, racemose or paniculate cymes terminal on branchlets, cymes 1- or 2-flowered, internodes long, 10-44 mm long; peduncles 2-20 mm, stellate-pubescent; pedicels 2-10 mm long; bracts like stipules but reducing upwards,

lower ovate-cordate or oblique at base, about 8 mm long, reducing to very narrowly lanceolate bracts about 2 mm long, usually 3 at apex of peduncle, central the largest $4,5 \times 3,5$ mm, lateral $2,5 \times 1,5$ mm. *Calyx* 6 to 7 mm long, lobed to about midway, at first stellate-pubescent especially on nerves, usually coarsely so with hairs from a raised base, sometimes more finely stellate with intermingled gland-tipped hairs, with age becoming glabrescent and scarious; lobes deltoid often ciliate with long hairs; sinuses wide, at least in mature flowers. *Petals* bright yellow turning reddish brown with age, about 10 mm long, orbicular to oblong in upper third, narrowing into a waist which is pubescent, especially on margins which are usually densely fringed, produced below into a claw with infolded margins. *Stamens* about 7 mm long; filaments hyaline, obovate, pubescent on shoulders, overlapped at apex by anther bases; anthers ciliate. *Ovary* 5-lobed, 5-umbonate at apex, about 3 mm long, stellate especially on sutures; styles about 4 mm long. *Capsule* exerted from persistent calyx, about 6 mm long, 5-lobed and 5-umbonate at apex, stellate-pubescent, the hairs longer on the sutures.

Found in Fynbos and Renosterveld, on mountain slopes, in rocky crevices and stony plains. Recorded from Bellville and Paarl Districts northwards to Clanwilliam District.

CAPE.—Bellville: Visschers Hoek, *Compton* 13431 (NBG). Ceres: Ezelsfontein, *Esterhuysen* 20343. Clanwilliam: Blaauwberg, *Schlechter* 8466; near Olifants River, *Ecklon & Zeyher* Enum. 345 (S). Malmesbury: near Malmesbury, *Schlechter* 1633; near Hopefield, *Marloth* 8224. Paarl: "Paarlberg", *Drège* 7294; Wemmershoek Valley, *Esterhuysen* 17663. Piketberg: slopes adjoining the town, *De Winter & Verdoorn* 9062; Pikeniers Kloof, *Schlechter* 4341. Tulbagh: Tulbagh Road, *Rogers* 17055; 3,2 km N. of Hermon, *Marsh* 724. Vanrhynsdorp: Giftberg, *Phillips* 7377; 7379.

Characterized by the harsh, but fairly lax, stellate pubescence on the strongly cuneate leaves which vary considerably in size especially in width, and the lobing which is usually in the upper half but sometimes at the apex only. The calyx is sparsely stellate-pubescent at first, becoming glabrous and scarious as it matures. This may account for Turczaninow's description of his *H. presliana* as "calycibus inflatis", for on the specimen on which his description is based the calyx had reached the scarious stage. The lobes are deltoid, sometimes ciliate with long hairs and the sinuses wide.

In spite of the variation in pubescence and especially in the width of the leaves, the species is readily recognizable. This was confirmed when the specimens cited by Harvey under *H. patula* were found to include the wide range of leaf width reflected in the description above.

H. myrioclada Diels in Bot. Jb. 55: 359 (1919) may belong in *H. scabra* (see also Species Requiring Further Attention, p. 61).

The specimen figured by Jacq. in Hort. Schoenbr. t. 127 as *H. scabra* Cav. is *H. aspera* Wendl. (see note under that species).

Specimens of *Ecklon & Zeyher* Enum. No. 350 named "*H. scabra* Jacq. non Cav." are *H. aspera*, and the following are *H. scabra*: No. 344 (named *H. scordifolia*) and No. 345 (named *H. denudata*). A specimen of Enum. 351 (in SAM), labelled *H. biflora* Eckl. & Zeyh. is nearest *H. scabra*, but possesses characters reminiscent of other species, such as a densely pubescent calyx somewhat resembling that of *H. multiflora*.

Story 2990, which Pillans identified as "*H. citrusdalensis* Pillans sp. nov.", a name never published, falls within the range of variation of *H. scabra* Cav.

85. *Hermannia angularis* Jacq., Hort. Schoenbr. 1: t. 126 (1797); DC. Prodr. 1: 495 (1824); Harv. in F.C. 1: 197 (1860). Verdoorn in Flower. Pl. Afr. 41 t. 1604 (1970). Iconotype: Cape, cult., Hort. Schoenbr. 1: t. 126.

H. trifurca sensu Eckl. & Zeyh., Enum. 47, No. 370, partly; non L.

Suffrutex, 30–60 cm high, branching at base, branches spreading-ascending, reddish brown in parts, sub-branched, subdensely harshly stellate-pubescent, hairs short, 0,5–1 mm long, spreading or erect and then based on small tubercles, rarely glabrescent. *Stipules* narrowly ovate-lanceolate to linear-acute, with midrib usually obvious, 5–9 mm long, 1,5–3 mm broad near base. *Leaves* sessile to shortly petiolate, fascicled; blade obovate-cuneate, narrowly oblanceolate or linear-spathulate, 7–30 mm long, 3–12 mm broad, broadest at or near apex which is often truncate or rounded at 3- or more-toothed, sometimes entire and acute, upper and lower surfaces laxly stellate-pubescent, glabrescent, margins sometimes ciliate with stellate or tufted hairs. *Inflorescence* terminal on ultimate branchlets, 1- or more 2-flowered cymes arising from a fascicle of leaves, stipules and bracts; peduncles 4–10 mm long, stellate-pubescent; pedicels 2–6 mm long, stellate-pubescent; bracts linear-acute, about 5 mm long, 1 mm broad, ciliate. *Calyx* parchment-like, 8 mm long, lobed to about midway, net-veined, glabrous except for stellate pubescence on margins of lobes, 5-angled, angles extending from sinuses to base of calyx, the portion between being concave. *Petals* about 9–10 mm long, twisted, the shortly exerted portion orange-red shading to lemon-yellow; blade broadly oblong, 6–6,5 mm long, 5–6 mm broad, abruptly narrowed into a usually short claw, claw about 3 mm long with broadly infolded margins, minutely papillose within. *Stamens* about 5 mm long; filaments hyaline, oblong-obovate to obtrullate, apparently glabrous, overlapped by filament bases; anthers 2 mm long, ciliate. *Ovary* 2 mm long, stellate-pubescent, shortly stipitate stipe 0,5 mm long; styles cohering in a column, 3,5 mm long. *Capsule* subglobose, about 6 mm diam., usually enclosed by persistent perianth, stellate-pubescent, hairs short from a scaly base except on sutures where they are slightly longer. Fig. 1.3.

Found in the south-western Cape, in mountain passes and at the coast from Somerset West eastwards to the George District.

CAPE.—Caledon: Houw Hoek Pass, *Marloth* 4806; *Schlechter* 7781. George: Herold's Bay, *Acocks* 21232. Knysna: Keurbooms River, *Hutchinson* 1373. Mossel Bay: Cloete's Pass, *Acocks* 14635. Paarl: French Hoek Pass, *Esterhuysen* 18886. Riversdale: Garcias Pass, *Acocks* 15433; *Galpin* 3787. Somerset West: Gordon's Bay, *H. Bolus* 8076. Stellenbosch: Sir Lowry's Pass, *H. Bolus* 9925. Swellendam: Appelkraal, *Zeyher* 2006; Hemel en Aarde, *Zeyher* 2007b. Worcester: Steynsburg, *Esterhuysen* 15597.

The distinguishing characters are found mainly in the flowers. The parchment-like calyx is distinctly 5-angled, the angles extending from the sinuses to the base of the calyx with the portion between being concave. The calyx is broad at the base and the lobes do not spread nor reflex at any time. The shortly exerted petals are strongly twisted and lemon-yellow grading into orange-red. Characteristic too is the blade of the petal which is broadly oblong and several times longer than the basal claw.

The great variation in leaf-shape and pubescence suggests that this species has crossed with related species in the same area, the characteristic calyx being a dominant feature. Muir 1456 (PRE), named "*H. glabricaulis* Pillans n. sp. (ined.)" could, for example, be of hybrid stock, with *H. filifolia* var. *grandicalyx* as one parent.

H. angularis sensu Eckl. & Zeyh., Enum. 356 and sensu Reichb., Ic. Descr. Pl. Cult. t. 68 fig. 1, is *H. hyssopifolia* L.

None of the Ecklon & Zeyher specimens named *H. trifurca* L. belongs to the Linnaean species. Some are *H. flammula* (e.g. Zeyher 2009 in PRE! and Z!) and others *H. angularis* (e.g. Zeyher 2006 and 2007 in PRE! and Z!).

86. *Hermannia rudis* N.E.Br. in J. Bot., Lond. 39: 398 (1901); Adamson in Adamson & Salter, Fl. Cape Penins. 585 (1950). Type: Cape Peninsula, near Simonstown, *H. Bolus* 4950 (K, lecto.; PRE!; BOL!).

H. rudis var. *exserta* N.E. Br. l.c. (1901). Type: Cape, Miller's Point, S. of Simonstown, *Wolley Dod* 2997 (K, holo.; PRE, photo.).

H. orophila sensu Eckl. & Zeyh., partly, as to Ecklon & Zeyher Enum. 369 (S!; PRE, photo.). non Eckl. & Zeyh. (see note under *H. flammea*).

Low suffrutex, branching at base, branches spreading, ascending, sub-branched, upper ultimate branches short, rough, fairly sparsely stellate-pubescent or hispid with a few stiff hairs from a raised tubercle. *Stipules* lanceolate to oblanceolate, narrowly ovate-oblong or ovate, acute, 3–7 mm long, 0.5–3.5 mm broad. *Leaves* sessile or with a petiole up to 7 mm long; blade obovate-cuneate, 10–25 mm long 6–15 mm broad, broadly rounded to subtruncate and coarsely toothed at apex, roughly stellate-pubescent on both surfaces, glabrescent, often hispid on margins with stiff hairs from a tubercle. *Inflorescence* of 1- to 2-flowered cymes in the axils of upper and sub-terminal leaves of branches and the many, short, lateral branchlets; peduncles and pedicels very short, rarely up to 3 mm long. *Calyx* often red (not visible in dried specimens), hispid, especially on veins, with tubercle-based hairs, 7–8 mm long, lobed to midway, lobes oblong and abruptly narrowed into an apicule which is incurved (calyx lobes look truncate). *Petals* twisted, "pink", "pale yellow", "yellow-orange", 7–8.5 mm long, scarcely or shortly exserted from calyx; limb oblong narrowing about midway and then produced below into a fairly broad claw with infolded margins, pubescent at middle on rim with tubercle-based hairs. *Stamens* with hyaline filaments, oblong, slightly narrowed to base, about 3.3 mm long; anthers 2 mm long. *Capsule* bluntly pentagonal, lobes rounded at apex, hispid with tufted hairs on angles and apex, finely stellate-pubescent or glabrescent between angles.

Found in Coastal Fynbos or Renosterbos, in dry sandy soil in rocky areas and on slopes, usually facing the sea. Recorded from a restricted area in the southern part of the Cape Peninsula and around False Bay with outliers farther east at Potberg, Swellendam District and near Caledon.

CAPE.—Caledon: Plat-se-Berg, *Esterhuysen* 12961; Kogelberg, *Pillans* 9817; *Boucher* 500; 1391; near Rooi Els, *Taylor* 4903. Peninsula: Cape Town flower show, *Marloth* 8814; Fish Hoek, *Adamson* 3028; Simonstown, *Bolus* 4950. Swellendam: Potberg, *Thompson* 1129 (STE).

This species is characterized by the rather coriaceous calyx, which is often red and has the tips of the lobes infolded giving them a truncate appearance. The

pubescence is harsh, mostly of tufts of stiff hairs on a raised tubercle. The flowers, which are very short stalked, grow in the axils of the upper and sub-terminal leaves and so appear to be in heads at the ends of the branchlets. The degree to which the corolla is exserted from the calyx varies and is not combined with any other difference. It may even be due to the age of the flower for, while the petals are still tightly rolled, they seem to be farther exserted. The variety *exserta* is therefore not upheld here.

87. *Hermannia abrotanoides* Schrad., Hort. Goetting. 17 t. 11 (1809); Harv. in F.C. 1: 204 (1860); M. Friedrich et al. in F.S.W.A. 84: 11 (1969). Iconotype: Schrad., Hort. Goetting. 17 t. 11 (1809). (Typotype not traced).

H. bipinnata Burch., Trav. 1: 310 (1822). Type: Cape, Prieska, Moddergat, *Burchell* 1627 (K, holo.; PRE, photo.; PRE!; LE!).

H. multifida DC., Prodr. 1: (1824), nom. superfl.; Harv. in F.C. 1: 204 (1860). Type: as for *H. bipinnata* Burch.

H. halicacaba DC., Prodr. 1: 493 (1824); Harv. in F.C. 1: 204 (1860). Type: Cape, Prieska, Asbestos Hills, *Burchell* 2020 (K, holo.; PRE, photo.; PRE!; LE!).

Subherbaceous perennial, a low, bushy, leafy plant with several to many slender stems from a woody base; stems and branches densely to subslaxly canescent with silvery strigose and appressedly stellate hairs, hairs fine and many from a central scale, minute glandular hairs often present. *Stipules* subulate and some upper ones linear-lanceolate, 3–10 mm long, subslaxly stellate-pubescent. *Leaves* basal and cauline, petiolate; blade 10–40 mm long, pinnately to palmately divided to midrib or almost so, pinnae divided again with ultimate lobes obtuse and decurrent, densely to subslaxly appressedly stellate-pubescent; petiole 5–40 cm long. *Inflorescence* of 1- to 2-flowered cymes, terminal on branchlets and in axils of upper leaves, forming lax, leafy, racemose cymes; flowers few and large; peduncles 5–20 mm long; pedicels 3–7 mm long; bracteoles subulate to narrowly deltoid, 1.5–5 mm long. *Calyx* inflated, subglobose, densely stellate-pubescent with appressed stellate hairs some of which are very shortly stalked and readily caducous, leaving glabrescent patches, green to papery, sometimes suffused with pink or purple, about 10 mm long when flattened, 5-lobed to less than halfway; lobes acute. *Petals* "golden yellow", "orange-red", yellow suffused in part with purplish pink, twisted, usually only shortly exserted from inflated calyx, about 11 mm long, subglobose in upper half, narrowed below into a rather broad claw which is incurved at base and has broad, infolded margins, margins minutely ciliate. *Stamens* about 8 mm long; filaments hyaline, more or less obovate, up to 4 mm broad at the shoulders. *Ovary* more or less globose, densely tomentose with short, light brown, stellate hairs; stipe under 1 mm long; styles 6 mm long. *Capsule* short, 5 mm long, more or less globose, overtopped by the persistent perianth.

Found on stony hills, in sand pockets between quartzite rock, on the edge of lime plateaux, among asbestos hills. Recorded from the Orange River basin in the Prieska and Kenhardt Districts northwards through Hay and Gordonia to South West Africa as far north as the Windhoek and Gobabis Districts. Also in Botswana.

CAPE.—Gordonia: Upington, *Van der Schijff* 8060. Hay: E. of Koegas, *Codd* 1244; Wolhaarkop, *Esterhuysen* 2438. Kenhardt: W. of Kenhardt, *Schlieben* 8833; S.E. of Pofadder, *Leistner* 2421. Prieska: near Asbestos Hills, *Marloth* 2022; *Burchell* 2020; Moddergat, *Burchell* 1627.

S.W.A.—Aroab: N. of Aroab, *Acocks* 18096. Gobabis: Witvlei, *Mason & Boshoff* 2513. Keetmanshoop: Klein Karasberg, *Dinter* 4857 (Z); *Galpin* 14172. Rehoboth: Farm Bergland, *Merxmüller* 835; between Göltschau and Windhoek, *Tölken & Hardy* 306. Windhoek: Finkenstein, *Seydel* 1748; Auaesberge, *Dinter* 7498.

Resembles *H. comosa* in some respects but is readily distinguished by the consistently deeply divided leaves. *H. abrotanoides* is characterized by the silvery stellate pubescence, together with the inflated calyx which is appressedly stellate-pubescent, the hairs fine and many from a silvery central scale, some very shortly stalked as well and these are readily caducous. *H. pulverata* has the same silvery stellate pubescence and resembles *H. abrotanoides* in the divided leaves but it can be distinguished mainly by the calyx which is not inflated.

The type figure is of a plant originally from the Cape, grown in the Herrenhaus en Garden. No specimen of the plant figured has been traced. There is a specimen in S which can be looked upon as authentic. It came from Lehmann's herbarium labelled "Missit Wendland. Cult. horto Herrenhusiano". Unfortunately the specific name is given as "*abrotanifolia*" instead of "*abrotanoides*", evidently by mistake.

88. *Hermannia pulverata* Andr., Bot. Rep. 3: t. 161 (1801); DC., Prodr. 1: 496 (1824) (sphalm "pulverulenta"); Eckl. & Zeyh., Enum. 47 No. 375 (1834); Harv. in F.C. 1: 203 (1860). Iconotype: Cape, cult. Hammersmith, t. 161 in Andr. Bot. Rep. 3 (typotype not traced).

H. argentea Sm. in Rees, Cycl. 17 (1819); DC., Prodr. 1: 496 (1824); Eckl. & Zeyh., Enum. 47, (No. 376 (1834)); Harv. in F.C. 1: 203. Type: Cape, cult. Leyden, *Smith* s.n. (BM, holo.; PRE, photo.!).

H. bolusii Szyszyl., Polypet. Thalam. Rehm. 19 (1887). Type: Orange Free State, Kanonfontein, *Rehmann* 3544 (Z, holo.!.; PRE, photo.!.; S!).

H. cana K. Schum. in Bot. Jb. 10: 42 (1888). Type: Cape, between Kuruman and Boetsap, *Marloth* 947 (PRE!; SAM!).

Subherbaceous perennial, about 30 cm tall or, if protected, taller, stems 1 to several from a woody base (or many after being heavily grazed), erect or spreading-ascending, sparsely branched above, silvery anescent with strigose and appressed stellate pubescence, the stellate hairs from a central, silvery scale, often minute, gland-tipped hairs present. *Stipules* fleshy, up to 10 mm long, ovate to ovate-oblong, broadly to narrowly so, often cordate at the base and oblique, silvery appressed stellate-pubescent. *Leaves* basal and cauline, petiolate; blade variable in shape and degree of lobing, broadly to narrowly ovate-oblong in outline, from coarsely lobed to pinnatipartite, bipinnatipartite or palmatipartite, silvery stellate pubescent to thinly so, lobes obtuse and decurrent; petiole 2–12 mm long. *Inflorescence* of 1- to 2-flowered cymes, terminal and in axils of upper leaves, forming racemose cymes; peduncles suberect, 5–30 cm long, rarely longer, appressed stellate-pubescent and often with scattered, minute, gland-tipped hairs; pedicels short, 1–6 mm long, nodding; bracts like stipules but usually smaller; bracteoles usually 3, 1–2 mm long. *Calyx* up to 5 mm long, campanulate, thin-textured, silvery stellate without, and usually with scattered, minute, reddish, gland-tipped hairs, lobed to almost halfway, sinuses wide. *Petals* usually under 10 mm long, "khaki yellow", "indigo to cream", "dirty yellow turning golden brown", tightly curled (flowers appear half closed and truncate on dried specimens), orbicular to oblong-orbicular, narrowing in lower half to a claw with infolded margins, apparently

glabrous. *Stamens* about 5 mm long with hyaline oblong-obovate filaments glabrous in specimens dissected; anthers about 2–5 mm long, slightly shorter than filaments, ciliate. *Ovary* about 2,5 mm long, stellate-pubescent, 5-lobed; stipe short, up to 0,75 mm long; styles 4,5 mm long. *Capsule* up to 8 mm long, appressed stellate-pubescent especially along sutures, remains of perianth persisting at base only.

Found in karroid scrub, karroid broken veld and false upper karoo, in vleis, shaly river valleys and rocky kloofs. Recorded from Worcester eastwards to Alexandria and northwards through Calvinia and Griqualand West through the Cape midlands to Fauresmith and Rouxville in the southern Orange Free State.

CAPE.—Alexandria: Addo Elephant Park, *Barnard* 558. Barkly West: Holpan, *Acocks* 109. Calvinia: Calvinia, *Schmidt* 163. Graaff-Reinet: Graaff-Reinet, *Thode* A549. Hanover: Hanover, *Sim* sub *Galpin* 5968. Hay: between Campbell and Griquatown, *Acocks & Hafström* H 1043. Herbert: Robenfontein, *Wenger* 1430. Kimberley: Blaauwbosdrift, *Acocks* 1146. Laingsburg: S.S.E. of Laingsburg, *Acocks* 20503. Mossel Bay: Karoo, "Gauritzrivier", *Ecklon & Zeyher* Enum. No. 375 (S). Middelburg: near Schoombie, *Schweickerdt* 1270; Grootfontein, *Theron* 1182. Oudtshoorn: Oudtshoorn, *Rogers* 4651. Pearson: Wildebeestkuil, *Hobson* 60. Port Elizabeth: "Coegariver", *Ecklon & Zeyher*, Enum. No. 376 (S). Prieska: Vogelstruisbult, *Bryant* J. 294. Prince Albert: Prince Albert Road, *Bayliss* 2443. Richmond: Vlakplaats, *H. Bolus* 13773 (Z). Robertson: Robertson, *Van Breda & Joubert* 1923. Steytlerville: De Weg, *Oliver* 4579. Uniondale: Toorwater, *Oliver* 3657. Willowmore: S.W. of Willowmore, *Bayliss* 4924. Worcester: Hex River Valley, *Marloth* 6192.

O.F.S.—Fauresmith: Koksfontein, *Henrici* 2814. Trompsburg: Riet Poort Noord, *Verdoorn* 2198. Rouxville: Nieuwejaarspruit, *Ecklon & Zeyher* s.n.

Characterized by the silvery, scaly pubescence which forms a complete, smooth covering on the stems in the lower parts and consists of strigose and stellate hairs, the stellate hairs radiating from a central silvery scale. In most upper parts the silvery stellate hairs and scales are less dense and often scattered, and minute reddish gland-tipped hairs are present as well. The leaves, like those of several other species, especially among species that were formerly in the genus *Mahernia*, vary considerably in the degree of lobing. In some specimens the leaves are merely coarsely lobed while in others, or even on the same plant, they can be deeply lobed. In this species they vary from subentire to coarsely lobed to pinnatipartite, bipinnatipartite or palmipartite.

Andrews, when describing this species, referred to it as the "powdered *Hermannia*".

89. *Hermannia procumbens* Cav., Diss. 329, t. 177, fig. 2 (1788). Type: Cape, "Groenekloof infra Leeuwestaart", *Thunberg* s.n. (MA, holo.; PRE, photo.!.; UPS, Herb. No. 15490, PRE, photo.!).

Suffrutex, stems one to many from a woody base, decumbent, slender, sparingly branched at base and sometimes with a few, short, ascending branchlets produced in axils of leaves along the trailing stem, new growth with appressed stellate pubescence, glabrescent, upper internodes long. *Stipules* ovate-oblong, ovate-lanceolate, semi-orbicular, 2–45 mm long, 1,5–2,5 mm broad, broadly acuminate to abruptly narrowed into an acumen, occasionally rounded at apex. *Leaves* usually solitary at a node, upper distant, petiolate; blade 10–35 mm long, varying in shape and degree of lobing, from oblong-cuneate and coarsely lobed to bi- or tri-pinnatisect and then fragile, fairly sparsely stellate-pubescent, glabrescent; petiole 3–15 mm long. *Inflorescence* of

few-flowered, leafless, racemose cymes, terminal on ascending branches and branchlets; flowers secund and often crowded at apex; pedicels short, up to 5 mm long. Calyx 5–7 mm long, from broadly campanulate (sub-inflated) and about half as long as petals to narrowly campanulate (not at all inflated) and more than half as long as petals, lobed to above the middle, lobes either broad-based and rounded with an acute apex, or deltoid to narrowly deltoid from a narrow base, glabrescent, sometimes with minute hairs persisting on margins and apex of lobes. *Petals* strongly twisted, 8–11 mm long, 3–5 mm broad in upper half, evenly narrowing into claw or broadest on one side and sometimes auricled on one side, claw about as long as upper portion, apparently glabrous or rarely a few hairs on inrolled margins. *Stamens* about 6.5 mm long, with narrow to fairly broad, obovate-cuneate, hyaline, glabrous filaments about 4 mm long; anthers 3 mm long, ciliate. *Ovary* about 2.5 mm long, densely stellate-pubescent, 5-lobed; stipe 4–5 mm long. *Capsule* up to 8 × 7 mm, 5-lobed, stellate-pubescent, subglabrescent, with the persistent calyx surrounding base.

Found on the Cape Peninsula and up the coast from Malmesbury District to near Lamberts Bay in the Clanwilliam District.

For key to subspecies see key to species (pp. 3–7).

(a) subsp. *procumbens*

De Winter in *Bothalia* 11, 3: 264 (1974).

H. procumbens Cav., Diss. 6: 329, t. 177, fig. 2 (1788); Thunb., Diss. Herm. 15 (1794); Fl. Cap. 507 (1823); Eckl. & Zeyh., Enum. 41, No. 329 (1834); Harv. in F.C. 1: 185 (1860). Adamson in Adamson & Salter, Fl. Cap. Penins. 584 (1950). Type: Cape, "Groenkloof infra Leeuwestaart", Thunberg s.n. (MA, holo.; PRE, photo.; UPS, Herb. No. 15490; PRE, photo.!).

H. leucanthemoides Presl. Bot. Bemerk. 22 (1845). Syntypes: *Ecklon* in Herb. U.I. 395 (PRE!; S!; W!); *Drège* pl. cap. b. spei.

H. zeyheriana Presl, Bot. Bemerk. 22 (1845); Walp., Ann. 1: 108, as *zeyheri* (1848–49). Type: *Ecklon & Zeyher* Enum. No. 329 (S!; LE!; MO!; BOL!).

Characterized by the decumbent habit with one to several slender stems from a woody base, the lower leaves oblong-cuneate and fairly coarsely lobed, the upper often narrowly oblong and lobed down to half the breadth of the leaf or in specimens from northern areas even deeper, but not to the midrib (pinnatifid), the subsparsely appressed, stellate pubescence of the young growth, the inflorescence of few-flowered, leafless, racemose cymes terminal on the ascending branches and branchlets, flowers secund and often crowded at the apex, the broadly campanulate (subinflated?), glabrescent calyx usually about half as long as the petals and lobed to above the middle and the lobes broad-based.

Recorded from the Cape Peninsula, around Table Bay and one record from near Bok Point in the Malmesbury District.

CAPE.—Bellville: Melkbosstrand, *Dahlstrand* 1044; about 45 km N. of Cape Town on Mamre road, *Lewis* in SAM 65979. Malmesbury: near Bok Point, *Compton* 9410 (NBG). Peninsula: Milnerton, *Adamson* 2605 (BOL); near Greenpoint, *Ecklon* in Herb U.I. 395.

Presl, when describing *H. leucanthemoides* and *H. zeyheriana*, stated that *Drège* 2316 (W!; LE!) and 7310 (W!; LE!) were the true *H. procumbens* Cav. He then described *Ecklon & Zeyher* Enum. No. 329 as *H. zeyheriana* Presl and *Ecklon* in Herb. U.I. 395 as *H. leucanthemoides* Presl. Several sheets in different herbaria of *Ecklon & Zeyher* Enum. No. 329 (MO!; BOL!; S!; LE!) and *Ecklon* in Herb. U.I. 395 (S!; W!) have been seen and they are true *H. procumbens*

Cav. The *Drège* specimens seen by Presl are correctly cited by Harv. in F.C. 1, No. 2316 (W; LE) under *Mahernia pulchella* (L.f.) Cav. and No. 7310 (W; LE) under *Mahernia linearis* Harv. Sheets of these *Drège* numbers have been seen in W and LE and they are not *H. procumbens* Cav.

Previously subspecies *procumbens* had only been recorded from around Table Bay which is some distance from the southernmost record of subsp. *myrrhifolia*. But in 1940 a specimen of typical *H. procumbens*, *Compton* 9410, was collected at the 7th Gate to Bok Point, which lies in the heart of the distribution area of subsp. *myrrhifolia*. This supports the decision to regard these elements only as subspecies. It may be due to cultivation or chance that more specimens of both subspecies have not been recorded from the intervening gap. In habit and inflorescence the two subspecies are the same and both show a tendency to turning blackish in parts on pressed specimens. For the features in which they differ see subsp. *myrrhifolia*.

(b) subsp. *myrrhifolia* (Thunb.) De Winter in *Bothalia* 11: 264 (1974). Type: Cape, Swartland, *Thunberg* Cat. No. 15487 (UPS, holo.; PRE, photo.!).

H. myrrhifolia Thunb., Diss. Herm. 16 (1794); Fl. Cap 508 (1825). Type: as above.

H. pinnatisecta Salter in JI S. Afr. Bot. 12: 102 (1946). Type: Cape, Malmesbury, Mamre Hill, *Compton* 14928 (NBG, holo.!). —var. *auriculata* Salter l.c. 103 (1946). Type: Cape, Malmesbury, Ysterfontein, *Compton* 17374 (NBG, holo.!).

This subspecies differs from the typical subspecies mainly in the leaves and calyx. The leaves are pinnatisect with pinnae pinnately lobed, some lobes decurrent (they are never oblong and coarsely lobed with upper narrow and pinnatifid as in subsp. *procumbens*). The calyx is usually narrowly campanulate in subsp. *myrrhifolia* and slightly more than half the length of petals whereas in subsp. *procumbens* it is broadly campanulate and about half as long as petals. This subspecies is on the whole more fragile than the typical, especially the leaves; the internodes appear longer and the tendency to turn blackish on pressing is more apparent.

Found along the Cape west coast from Malmesbury District to Clanwilliam. Recorded from the Swartland, especially near Saldhana Bay and northwards to Lambert's Bay.

CAPE.—Bellville: Monte Vista, *Esterhuysen* 32491a, Clanwilliam: Van Putten's Vlei, *Gillett* 4058; Zuurfontein, *Schlechter* 8549. Malmesbury: Swartland, *Thunberg* s.n. (S); Mamre Hill, *Compton* 14928 (NBG); Ysterfontein, *Compton* 17374 (NBG); near Darling, *Schlechter* 5339 (SAM).

Records of this subspecies are found in very few herbaria. This is probably owing to the fragile nature of the plant and to the extensive cultivation in the Swartland, Malmesbury district, which is evidently its main distribution area. It would seem that Thunberg's species was lost sight of by most reviewers, possibly because the name was misapplied by Ecklon & Zeyher. Their No. 407, mentioned in the Enumeration under the name *Mahernia myrrhifolia* (Thunb.) Spreng., is not this species but *H. diffusa* (= *H. pilosula* Harv.).

So it happened that Salter came to describe the species *H. pinnatisecta*. His specimens exactly match the type of *H. myrrhifolia* Thunb.

90. *Hermannia confusa* Salter in JI S. Afr. Bot. 12: 99 (1946); De Winter in *Bothalia* 11, 3: 263 (1974); Verdoorn in Flower. Pl. Afr. 43, t. 1718 (1976). Type: Cape, between Caledon and Babylon's

Tower, *Ecklon & Zeyher* Enum. No. 374 (BOL, holo.; S!; LE!; SAM!).

H. tenuifolia sensu Eckl. & Zeyh., Enum. 47, No. 374 (1834); sensu Harv. in F.C. 1: 203 (1860), non Sims.

H. coronopifolia sensu Eckl. & Zeyh., Enum. 47 No. 377 (1834), non Link. (S!; SAM!).

Mahernia pinnata sensu Eckl. & Zeyh., Enum. 52: 408 (1834), non L. (S!, poor specimen).

Suffrutex, erect, becoming much branched and sprawling with age, up to 60 cm tall, branched from base; branches and branchlets rather slender with fairly sparse, appressed, stellate hairs and long, pointed hairs spreading from a minute, bulbous base, minute, gland-tipped hairs also sometimes present, the long hairs caducous. *Stipules* 2–6 mm long, ovate to narrowly ovate, often broad and oblique at base, the auricles somewhat thickened. *Leaves* 10–25 mm long, one or more at a node, pinnately lobed to bi-pinnately lobed above, narrowing into a petiole-like base up to 1 cm long, sparsely stellate-hairy. *Inflorescence* of 1- to 2-flowered cymes arranged in slender, leafless, lax, racemose cymes terminal on branchlets, cymes 1 to 2 at a node; peduncles 1–4,5 mm long, sparsely stellate-pubescent, glabrous or with minute, gland-tipped hairs, usually straight and suberect, usually shorter than internodes; pedicels short, 3–4 mm long, cernuous; bracts like stipules, narrowly ovate to ovate with a broad attachment, shallowly cordate or often oblique with one side deeply cordate, auricles somewhat thickened, acute or acuminate, glabrous or with a few long hairs which fall readily; bracteoles small and often united at base, 1,5–2,5 mm long. *Calyx* campanulate, lobed to almost middle, about 6 mm long, glabrous; lobes acute. *Petals* bright yellow turning red-orange with age, strongly twisted, about 10 mm long, the sub-orbicular upper half oblique at base where it narrows into a long claw with infolded margins, minutely pubescent in central area on inner face. *Stamens* about 6 mm long with obovate hyaline filaments, pubescent on shoulders which are overlapped by anther bases. *Ovary* about 3 mm long, 5-angled, stellate-hairy; stipe up to 1 mm long; styles about 8 mm long. *Capsule* 6–7 mm long, 5-lobed, shortly exerted from the persistent calyx, stellate-pubescent at least on sutures and at apex; styles fairly persistent.

Found on river flats and mountain slopes. Recorded quite frequently from Caledon eastwards to Swellendam and northwards through Robertson, Worcester and Stellenbosch to Piketberg and in eastern Clanwilliam.

CAPE.—Caledon: Zwarteberg, *Schlechter* 5557; Hartebees-rivier, *Zeyher* 2001; *Ecklon & Zeyher* Enum. 374 (LE; W). Ceres: Ezelsfontein, *Esterhuysen* 20359. Clanwilliam: Berg-valley, *Oliver* 3893. Piketberg: Piqueniers Kloof, *Schlechter* 4940. Robertson: near Warsbek, *Van Breda & Joubert* 2006. Stellenbosch: Stellenbosch, *Ecklon & Zeyher* Enum. 408 (S). Swellendam: Hesquaspoort, *Acocks* 22391. Tulbagh: Tulbagh Road, *Schlechter* 8995. Worcester: Hex River, De Doorns, *H. Bolus* 13076.

In the past this species has very generally been named *H. tenuifolia* Sims. In 1946 Captain Salter pointed out that the specimens cited by Harvey in the Flora Capensis, together with a number of more recently collected examples, differ from Sims' species. Sims states in the text of the Botanical Magazine t. 1348 (1811) that the plate had been prepared some years before from a plant believed to have been in the possession of the late Mr Curtis. No specimen was preserved and, since it has not been exactly matched with any known South African species, *H. tenuifolia* Sims is now considered an insufficiently known species.

H. confusa differs from its nearest relative, *H. procumbens* subsp. *myrrhifolia*, in its erect habit and its inflorescence of lax racemose cymes with long, suberect peduncles which are usually somewhat shorter than the internodes. It is also characterized by the fairly shallow, glabrous calyx with the petals exerted from the tube by more than half, often showing the claw with its stellate hairs.

In his original description of *H. confusa* Salter did not clearly indicate *Ecklon & Zeyher* Enum. No. 374 as the holotype. He did, however, mention this specimen first and added BOL in brackets after it. In the rest of the work Salter always indicated in brackets behind the first cited specimen that it is the type and also the herbarium in which it is housed. It is thus assumed that the omission of the word type is merely an error.

91. *Hermannia macra* Schltr. in Bot. Jb. 55: 362 (1919); M. Friedrich et al. in F.S.W.A. 84: 16 (1969). Syntypes: Namaqualand, l'us, *Schlechter* 11403 (PRE!; Z!; W!; S!; LE!); Keuzabies, 18/6/1898, *M. Schlechter* s.n. or sometimes given as No. 106 (K!; PRE!; Z!; LE!; S!).

H. rhopalostylis K. Schum. & Schltr. ined., name on some herbarium specimens of *Schlechter* 11403 and *M. Schlechter* 106.

H. paniculata E. Mey., nomen in Drège, Zwei Pfl. Doc. 191 (1843) (W!).

Suffrutex, stems several to many from a woody base, sparingly branched near base; branches sparsely to very sparsely and minutely appressed stellate-pubescent, the hairs radiating from central scales or glands, scattered minute papillae sometimes present, glabrescent, sometimes central scales or glands persistent. *Stipules* small, narrowly ovate to ovate-deltoid, broad at base, 1,5–2 mm long, stellate-pubescent and sparsely ciliate with long, pointed hairs, glabrescent. *Leaves* mostly basal, sparse and reduced above, petiolate; blade more or less oblong from narrowly to broadly so, or ovate-oblong, coarsely and unevenly lobed, sometimes deeply so but never to midrib, lobes usually broad and obtuse, not or occasionally lobed again, 3-nerved at base, nerves suberect, appressed stellate-pubescent on both surfaces, glabrescent; petiole 5–25 mm long. *Inflorescence* of 1- to 2-flowered cymes arranged in erect, terminal, leafless, racemose or paniculate cymes; peduncles 20–30 mm long, glabrescent; bracteoles like small stipules, usually 3; pedicels 2,5–6 mm long, stellate-pubescent with minute, scattered glands or papillae. *Calyx* campanulate, about 4,5 mm long, lobed to almost middle, teeth deltoid and sinuses wide, stellate-pubescent and with minute, scattered scales or papillae, glabrescent in upper half only, lobes ciliate with slightly longer stellate hairs. *Petals* yellow to orange-red, about 5,5 mm long, suborbicular in upper half, usually broader than long, narrowed into a fairly broad claw with inrolled margins, appears glabrous but sometimes with minute hairs. *Stamens* about 5 mm long, with obovate, hyaline filaments; anthers almost as long as filaments, overlapping them at base, acute, ciliate. *Ovary* about 2,5 mm long, stellate-pubescent on sutures, papillate between; stipe about 0,5 mm long; styles 3 mm long, persistent, often appearing subclavate at apex. *Capsule* about 6 mm long and almost as broad, shallowly 5-lobed, stellate pubescence sometimes persisting on sutures, papillose between hairs, persistent styles still united and appear subclavate at apex (hence the abandoned manuscript name *rhopalostylis*).

Found on sandy flats and in dry river beds in the drainage basin of the lower Orange River. Recorded from Namaqualand and in South West Africa in the Warmbad and Lüderitz Districts.

CAPE.—Namaqualand: l'us, *Schlechter* 11403; Keuzabies, *M. Schlechter* 106; S. of Goodhouse, *Schlieben* 9100.

S.W.A.—Lüderitz: Sendelingsdrift, *Merxmüller & Giess* 3261. Warmbad: Sperlingspütz, *Giess, Volk & Bleissner* 7012; Witpütz, *Merxmüller & Giess* 3635.

Closely related to *H. paucifolia* and differs mainly in the shape and lobing of the leaf and size of the flowers. In *H. macra* the flowers are small, the majority up to 6 mm long on dried specimens, whereas in *H. paucifolia* they are up to 10 mm long. The leaves in *H. macra* are more or less oblong, from narrowly to broadly so, and coarsely and unevenly lobed, rarely deeply lobed but not to the midrib, whereas in *H. paucifolia* the leaves are ovate and the lobing is usually to the midrib so that most of the lower leaves are palmatisect. Both these species are characterized by being fairly small, 30–50 cm tall, with several stems from a woody base and with leaves mostly basal and an inflorescence of practically leafless, glabrous, racemose or paniculate cymes. The styles which cohere and persist, appear subclavate and this probably accounts for the unpublished specific name *H. rhopalostylis*. The name "*macra*", the "Meagre *Hermannia*" was chosen instead when the species was published in 1919.

92. *Hermannia juttae* Dinter & Engl. in Bot. Jb. 55: 356 (1919); M. Friedrich et al. in F.S.W.A. 84: 16 (1969). Type: South West Africa, Büllspoor, Rehoboth, Dinter 2098 (SAM!).

H. rehobothensis M. H-Friedrich in Mitt. bot. StSamml., Münch. 1: 346 (1953); M. H-Friedrich et al. in F.S.W.A. 84: 16 (1969), in syn. Type: South West Africa, Rehoboth, Volk 2520.

Subherbaceous, stems several to many from a woody base, erect, sparingly branched just above base, densely stellate-pubescent at base with long white hairs, branches sparsely and inconspicuously stellate-pubescent, often with scattered, very minute stipules, especially in upper portion. *Stipules* ovate-lanceolate to linear-lanceolate, somewhat acinaciform, 5–20 mm long, stellate-pubescent. *Leaves* petiolate, mostly basal with 1 or 2 distant leaves on lower half of branches; blade oblong-lanceolate to narrowly lanceolate, coarsely crenate or toothed, 20–60 mm long, 8–15 mm broad, occasionally luxuriant plants with larger leaves (*Giess* 13555), stellate-pubescent, at first densely so with long matted white hairs, later sparsely so with shorter, appressed hairs, nerves prominent below, usually 3 from base; petiole 7–27 mm long. *Inflorescence* of 1- to 2-flowered cymes, arranged in erect, leafless, lax, terminal, racemose cymes; cymes 1 to 2 at a node; peduncles suberect, 15–35 mm long, appearing glabrous but usually with scattered, minute, subsessile glands; bracts like stipules, though somewhat smaller, bracteoles often 3, 1.5–5 mm long; pedicels slender, 5–15 mm long. *Calyx* 8–9 mm long, campanulate, wide at mouth, thin becoming papery, appears glabrous but has minute scattered glands and occasionally a few stellate hairs, toothed in upper half, sinuses wide. *Petals* golden yellow becoming orange-red with age, 8–9 mm long, oblong-orbicular in upper half, narrowing into a fairly broad claw with narrowly infolded margins, glabrous in specimens dissected. *Stamens* 8 mm long with obovate-oblong, hyaline filaments; anthers acute, ciliate, slightly longer than filaments. *Capsule*

about 8 mm long, enclosed in faded petals and calyx, 5-lobed, stellate-pubescent; style persistent.

Found "on the flats", in deep sandy soil, "among *Acacias*", "among *Mesembryanthemum*". Recorded from the Rehoboth and Maltahöhe Districts in South West Africa.

S.W.A.—Maltahöhe: form Schwarzkuppe, *Giess, Volk & Bleissner* 5215. Rehoboth: Büllspoor, Dinter 2098 (SAM); Strej 2085; Liebenberg 5106; Dinter 8321 (S; PRE); Jorro Flats, Strej 2339; Naukluft, Hardy 1960.

A low, subherbaceous plant with many short, erect, thin, pubescent stems from a woody base, sparsely branched just above the base. Characterized by the basal leaves with only one or two above the base in the lower half of the plant, and the leafless upper half which bears the comparatively large flowers in lax racemose cymes, the calyx, which is campanulate, with a wide mouth and appears glabrous although minute glands and occasional stellate hairs may be present.

93. *Hermannia paucifolia* Turcz. in Byull. mosk. Obshch. 31: 218 (1858); Harv. in F.C. 1: 203 (1860); M. Friedrich et al. in F.S.W.A. 84: 19 (1969). Type: Cape, Bitterfontein, Zeyher 118 (K; PRE, photo.!, PRE; J!; LE!; and in W! as "*Mahernia bipinnata* L."; in S! as "*H. dissecta* Harv.").

H. chrysanthemifolia E. Mey. ex Harv. in F.C. 1: 204 (1860). Type: Namaqualand, Kaus Mts, Drège s.n. (W!; LE!).

H. paucifolia var. *intermedia* Kuntze ex K. Schum. in Verh. bot. Ver. Prov. Brandenb. 30: 233 (1888); in Engl. Monogr. Afr. Pl. 5: 55 (1900). Type: no type designated but several specimens cited in 1900, among them *Schenck* 342 (Z!) and 124 (Z!; PRE!).—var. *chrysanthemifolia* (E. Mey. ex Harv.) Kuntze ex K. Schum., l.c. (1888); in Engl. l.c. (1900).

H. dissecta Harv.ms. in syn. in F.C. 1: 204 (1860). Type: as for *H. paucifolia* Turcz.

Suffrutex, stems several to many, bushy, from a woody base, branched at base and sparingly above, branches glabrous or with a few hairs or minute glandular hairs, rarely finely stellate-pubescent. *Stipules* small, broadly ovate to ovate-lanceolate, 1–3, 5 mm long, glabrous or subslaxly pubescent, some hairs on margins long. *Leaves* mostly basal with a few distant and somewhat reduced leaves above, petiolate; blade 15–30 mm long, usually palmatisect with segments pinnately and unevenly once or twice lobed, lobes mostly rounded at apex, leaves rarely ovate and palmately nerved with margins shallowly to deeply lobed, upper and lower surface glabrous or sparsely to densely stellate-pubescent with minute stellate hairs, upper surface sometimes glabrescent; petiole 10–35 mm long. *Inflorescence* of 1- to 2-flowered racemose or paniculate cymes, terminal on main branches and on a few lateral branches which arise from distant upper, much reduced leaves; peduncles suberect, up to 16 mm long; bracts short and broad, often united at base, about 1 mm long; pedicels 2–3 mm long, often minutely glandular-pubescent. *Calyx* campanulate, wide at the mouth, about 6, 5 mm long, lobed almost to middle, minutely stellate-pubescent, glabrescent with only a few minute glandular scales at base. *Petals* yellow to orange, at some stages red, about 10 mm long, the upper third oblong-orbicular, narrowing into a long claw with inrolled margins, rounded or slightly lobed where blade narrows into claw, appears glabrous but sometimes minute stellate pubescence and papillae obvious on inner face of claw. *Stamens* united at base around stipe, about 7 mm long with oblong hyaline filaments narrowing slightly to base; anthers ciliate 4 mm long, about as

long as filaments and shortly overlapping them at base. *Ovary* about 4 mm long, entirely stellate-pubescent or only on sutures, papillate between, sutures narrowing slightly to base; stipe 1 mm long; styles about 5 mm long, exerted and persistent, appearing slightly clavate at apex. *Capsule* 7–10 mm long, minutely papillose between sutures, sometimes stellate on sutures and at apex, persistent calyx and stamens at base obscuring stipe, persistent styles at apex.

Found in the western mountainous karoo, the arid upper karoo, Namaqualand and south-western South West Africa. Recorded from Victoria West westwards to Calvinia and northwards to Namaqualand and the Lüderitz District in South West Africa.

CAPE.—Calvinia: Hantam, *Marloth* 5634; on road to Williston, *Story* 4270; Brandvlei, *Comins* 679. Namaqualand: Oograbies Poort, *H. Bolus* in Herb. Nor. Austr.-Afric. 440; Kaus Mts, *Drège* s.n. (LE; W). Vanrhynsdorp: Bitterfontein, *Zeyher* 118. Victoria West: Hutchinson, *Acocis* 9631. Williston: Matjiesfontein, *Foley* 160; Victoria West station, *Smith* 2452.

S.W.A.—Lüderitz: Aus, *Dinter* 6072; *Marloth* 5079; between Tsiurub and Grasspoorte, *Schenck* 124 (PRE; Z); Gobaxab, between Aus and the Orange River, *Schenck* 342 (Z); Klinghardt Mts, *Dinter* 3884.

Characterized by the mainly basal leaves, ovate in outline and often deeply palmatisect, and the almost leafless, terminal, paniculate cymes. Closely related to *H. macra*. For distinguishing features see under that species. The distribution of these two species overlap and some specimens appear to be intermediate. For the present the treatment in F.S.W.A. is followed here and the two species are kept separate. *Dinter* 3884, which in F.S.W.A. is doubtfully included in this species because of the shallowly lobed, densely stellate leaves, matches a specimen from Grootderm collected by Pillans (No. 5324), with the note "luxuriant growth result of growing in deep sand in a watercourse". Among the specimens examined these two gatherings are linked to the palmatisect leaves by *Schenck* 342 (Z) which has intermediate leaves, some shallowly, and others on the plant fairly deeply lobed. *Dinter* 3884 and *Pillans* 5324 are therefore here included in *H. paucifolia*.

The type gathering, *Zeyher* 118, is represented in several herbaria. All those seen are poor specimens. It is not known which, if any, of these specimens was seen by Turczaninow.

Drège specimens in LE and W which are this species have, evidently in error, the specific name written as "*chrysanthemoides*" on the label.

According to Veterinary Services, Onderstepoort these plants cause excessive purging in animals. Common names are Skitterybossie, Purgurbossie, Scholtzbossie and Governmentbossie. In the Agricultural Journal (1893), it is claimed that it is used to cure Bushman of a craving for drink.

SPECIES REQUIRING FURTHER ATTENTION

1. *Hermannia bracteosa* Presl, Bot. Bemerk. 21 (1844).

The sheet of *Drège* 7267 in PR comprises two elements. The specimen on the left is *H. mucronulata* Turcz., and from the description in Bot. Bemerk. it is clear that this is the specimen that Presl referred to as *H. velutina* Eckl. & Zeyh. The specimen on the right which is considered to be the holotype of *H. bracteosa* Presl, does not agree with any species known to me. The leaves are velvety as in *H. velutina*, but the inflorescences matches *H. salviifolia* var.

grandistipula Harv., which has coarsely stellate leaves. This seems to point to the holotype being of hybrid origin.

2. *Hermannia incisa* Willd., Sp. Pl. 3: 599 (1800).

The type specimen of this species is in the Botanical Museum, Berlin-Dahlem. A photograph of the type specimen was sent to this Institute and later a flower and upper leaf was sent on loan. It appeared that in all probability the species was conspecific with *H. procumbens* Cav. and matched fairly well *Lewis* in SAM 65979 under *H. procumbens* subsp. *procumbens*. However, it seems wise to investigate further, especially since the procumbent habit is not mentioned and cannot be judged from the specimen. The sign on the specimen indicated that it was woody but not necessarily procumbent.

3. *Hermannia myrioclada* Diels in Bot. Jb. 55: 359 (1919).

Type: Cape, Cedarberg, *Diels* 862 (B, holo.†). From the description this species may be synonymous with *H. scabra*.

4. *Hermannia polymorpha* Eckl. & Zeyh.

The specimen figured in Refug. Bot. 3: 195 together with a specimen in LE labelled "Ex horto bot. Petropolitana 66.5" and named *H. polymorpha* Eckl. & Zeyh. were most puzzling. In 1975 a specimen from Kew was brought to my notice. It matched the above and was said to have appeared spontaneously in the Royal Botanic Gardens, Melbourne, Australia. That means no original locality was known for any of these and since they did not match any of the thousands of southern African species examined, it seemed probable that South Africa was not the country of origin. In 1976 a specimen from the Bolus Herbarium, that had been overlooked when the collection from that herbarium was sent on loan to this Institute, was received here. It matches the above specimens and is labelled *Gillett* 1452 from "Avontuur, edge of Plateau, above Bidou River, Knysna". It may be a good species near *H. angularis* or a sport or form of that species.

5. *Hermannia urceolata* Pillans MS.

Pillans evidently originally intended naming this species *H. hollandii*, but the name is scored out in his manuscript and "*urceolata*" written in its place. The specimens cited are as follows: "Port Elizabeth Drive, Cape Road, St. Alban's Farm, *Holland* 4062 (type in Bolus Herb.); 15th Mile Cape Road, *Long* 5056; without precise locality, *Cruden* 465; *Bolus* 3055; Baakens River Valley, *Kensit* 2". These sheets have been seen in the Bolus Herbarium. The number of *Long*'s specimen is mistakenly printed as "5056", which is the genus number. The correct number is *Long* 1302. *Cruden* 465 and *Kensit* 2 have been found to be *Hermannia suavis*. Although Pillans's MS species resembles both *H. suavis* and *H. salviifolia* var. *grandistipula* in the urceolate calyx with rather long, white, stellate hairs and in the general leaf shape and size of stipules, it differs from both in the distinct stellate pubescence on the lower surface, with the hairs long, whitish and multicellular, giving the leaves a fringed look around the margin when viewed from above. To date, field observations have not been carried out in order to establish whether it is a distinct species.

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UITTREKSEL

Waarnemings van die genus as geheel word gedoen en die subgenus *Hermannia* word omskrywe. Spesies in Suidelike Afrika wat onder hierdie subgenus sorteer word in besonderhede hersien. 'n Sleutel tot hierdie 93 spesies word verskaf en 'n aantal pentekeninge illustreer sommige van die diagnostiese kenmerke wat in die sleutel gebruik word.

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<i>arabica</i> Hochst. & Steud. ex Fisch.	16	var. <i>passerinoides</i> Harv.	51
<i>argentea</i> Sm.	57	var. <i>robusta</i> Verdoorn	52
<i>argyrata</i> Presl	22	<i>filipes</i> Harv.	16
<i>asbestina</i> Schltr.	21	var. <i>eliator</i> K. Schum.	16
<i>aspera</i> Wendl.	47	<i>flammea</i> Jacq.	53
<i>aspericaulis</i> Dinter & Engl.	21	<i>flammula</i> Harv.	53
<i>atrosanguinea</i> Dinter	16	<i>floribunda</i> Harv.	26
<i>ausana</i> Dinter ex Range	31	<i>floribunda</i> sensu K. Schum.	29
<i>bicornis</i> Eckl. & Zeyh.	20	<i>fruticulosa</i> K. Schum.	21
<i>bipinnata</i> Burch.	56	<i>gariepina</i> Eckl. & Zeyh.	18
<i>bolusii</i> Szyszyl.	57	var. <i>dentata</i> Engl.	18
<i>boranginiiflora</i> Hook.	11	var. <i>integrifolia</i> Engl.	18
<i>brachypetala</i> Harv.	9	<i>gilfillanii</i> N.E. Br.	51
<i>bracteosa</i> Presl.	61	<i>glabripetala</i> Engl.	31
<i>brandtii</i> Engl. ex Dinter	10	<i>glanduligera</i> K. Schum.	11
<i>bryonifolia</i> sensu Eckl. & Zeyh.	33	<i>glandulosissima</i> Engl.	12
<i>bryoniifolia</i> Burch.	26	<i>glomerata</i> E. Mey.	48
<i>cana</i> K. Schum.	57	<i>gracilis</i> Eckl. & Zeyh.	39
<i>candicans</i> Ait.	28	<i>grisea</i> Schinz	13
var. <i>discolor</i> Harv.	31	<i>guerkeana</i> K. Schum.	14
var. <i>incana</i> Harv.	31	<i>halicacaba</i> DC.	56
<i>candicans</i> sensu Harv.	28	<i>helianthemum</i> K. Schum.	18
<i>candissima</i> Spreng. f.	32	<i>helicoidea</i> Verdoorn	46
<i>cavanillesiana</i> Eckl. & Zeyh.	37	<i>hereroensis</i> Schinz	14
<i>chrysanthemifolia</i> E. Mey. ex Harv.	60	<i>hilaris</i> (Eckl. & Zeyh.) Hochr.	20
<i>chrysophylla</i> Eckl. & Zeyh.	36, 49	<i>hirsuta</i> Mill.	29
<i>collina</i> Eckl. & Zeyh.	22	<i>hirsuta</i> Schrad., non Cav.	47
<i>comosa</i> Burch. ex DC.	31	<i>hirsuta</i> Schrad. & Wendl.	45
var. <i>crenata</i> K. Schum.	31	<i>hirsuta</i> sensu Eckl. & Zeyh.	23
var. <i>minor</i> K. Schum.	31	<i>hispidula</i> Reichb.	27
<i>complicata</i> Engl.	19	<i>holosericea</i> Jacq.	37
<i>concinnifolia</i> Verdoorn	25	<i>holubii</i> Burtt Davy	16
<i>confusa</i> Salter	58	<i>hyssopifolia</i> L.	35
<i>conglomerata</i> Eckl. & Zeyh.	48	var. <i>integerrima</i> Schinz.	36
<i>cordifolia</i> Harv.	27	<i>imbricata</i> Eckl. & Zeyh.	25
<i>coronopifolia</i> sensu Eckl. & Zeyh.	59	<i>incana</i> Cav.	31
<i>cristata</i> H. Bol.	7	<i>incana</i> sensu Thunb.	37
var. <i>geoides</i> Beauv.	7	<i>incisa</i> Willd.	61
<i>cuneifolia</i> Jacq.	40	<i>intricata</i> Adamson	48
var. <i>cuneifolia</i>	41	<i>involuta</i> Cav.	49
var. <i>glabrescens</i> (Harv.) Verdoorn	41	<i>involuta</i> sensu Eckl. & Zeyh.	35
<i>cuneifolia</i> sensu Harv.	43	<i>johannisburgiana</i> Engl.	9
<i>damarana</i> Bak. f.	18	<i>johanssenii</i> N.E.Br.	30
<i>decipiens</i> E. Mey. ex Harv.	49	<i>joubertiana</i> Harv.	54
<i>decumbens</i> Willd. ex Spreng.	22	<i>juttae</i> Dinter & Engl.	60
var. <i>argyrata</i> (Presl) Harv.	22	<i>karakowisensis</i> ined.	10
var. <i>collina</i> (Eckl. & Zeyh.) Harv.	22	<i>kirkii</i> Mast.	16
var. <i>hispida</i> Harv.	22	<i>lancifolia</i> Szyszyl	10
<i>denudata</i> L. f.	52	<i>latifolia</i> Jacq.	36
var. <i>denudata</i>	52	<i>lava</i> <i>adulifolia</i> L.	37
<i>denudata</i> sensu Eckl. & Zeyh.	54	<i>lepidota</i> Buch. ex Krauss	41
<i>desertorum</i> Eckl. & Zeyh.	42	<i>leucanthemoides</i> Presl.	58
<i>dinteri</i> Engl.	14	<i>leucophylla</i> Presl	37
<i>dinteri</i> Schinz	31	<i>lindequistii</i> Engl.	18
<i>discolor</i> Otto & Dietr.	28	<i>linearifolia</i> Harv.	17
<i>disermifolia</i> Jacq.	33	<i>linifolia</i> Burm. f.	22
<i>disermifolia</i> sensu Eckl. & Zeyh.	22	<i>linifolia</i> sensu Eckl. & Zeyh.	51
<i>dissecta</i> Harv.	60	<i>longiramosa</i> Engl.	10
<i>disticha</i> Schrad.	48	<i>lugardii</i> N.E. Br.	16

	Page		Page
<i>macra</i> Schltr.	62	<i>rigida</i> Harv.	46
<i>melissifolia</i> Engl.	26	<i>rotundifolia</i> Jacq.	49
<i>membraniflora</i> Schltr.	41	<i>rudis</i> N.E.Br.	56
<i>merxmülleri</i> M. Friedrich	8	<i>rudis</i> var. <i>exserta</i> N.E.Br.	56
<i>micans</i> Schrad.	36	<i>rugosa</i> Adamson	28
<i>micrantha</i> Adamson	48	<i>salvifolia</i> sensu Eckl. & Zeyh.	34
<i>micropetala</i> Harv.	15	<i>salviifolia</i> L. f.	35
<i>mildbraedii</i> Dinter & Engl.	17	var. <i>salviifolia</i>	36
<i>minimifolia</i> M. Holzhammer	14	var. <i>ovalis</i> Harv.	36
<i>minutiflora</i> Engl.	29	var. <i>grandistipula</i> Harv.	36
<i>modesta</i> (Ehrenb.) Mast.	16	var. <i>oblonga</i> Harv.	36
var. <i>elator</i> (K. Schum.) K. Schum.	16	<i>salviifolia</i> sensu Cav.	49
subvar. <i>brevicornis</i> Engl.	16	<i>secundiflora</i> Eckl. & Zeyh.	41
subvar. <i>macropetala</i> Engl.	16	<i>sandersonii</i> Harv.	8
subvar. <i>mediipetala</i> Engl.	16	<i>scabra</i> Cav.	54
subvar. <i>virgatissima</i> Engl.	16	<i>scabra</i> sensu Jacq.	47
var. <i>tsumebensis</i> Engl.	16	<i>scoparia</i> (Eckl. & Zeyh.) Harv.	22
<i>mollis</i> Willd.	31	<i>scordifolia</i> Jacq.	24
<i>mollis</i> sensu Eckl. & Zeyh.	28	var. <i>integriscuscula</i> Harv.	24
<i>mucronulata</i> Turcz.	34	<i>scordioli</i> sensu Eckl. & Zeyh.	54
<i>multifida</i> DC.	56	<i>seineri</i> Engl.	9
<i>multiflora</i> Jacq.	43	var. <i>latifolia</i> Engl.	10
<i>muricata</i> Eckl. & Zeyh.	44	<i>seitziana</i> Engl.	14
<i>muirii</i> Pillans	25	<i>sideritifolia</i> Engl.	13
<i>myrioclada</i> Diels.	61	<i>solaniflora</i> K. Schum.	13
<i>myrrhifolia</i> Thunb.	58	<i>spinosa</i> E. Mey. ex Harv.	21
<i>nemorosa</i> Eckl. & Zeyh.	28	<i>spinulosa</i> Engl.	20
<i>nivea</i> Schinz	18	<i>squarrosa</i> Dinter ex Range	20
<i>odorata</i> Ait.	38	<i>stipulacea</i> Lehm. ex Eckl. & Zeyh.	50
<i>oligantha</i> Salter	46	<i>suavis</i> Presl ex Harv.	35
<i>orophila</i> Eckl. & Zeyh.	53	<i>sulcata</i> Harv.	38
<i>orophila</i> sensu Eckl. & Zeyh.	56	<i>tenella</i> Dinter & Schinz	17
<i>paniculata</i> E. Mey.	59	<i>tenuifolia</i> sensu Eckl. & Zeyh.	59
<i>pallens</i> Eckl. & Zeyh. var. <i>glabrescens</i> Harv.	41	<i>tenuipes</i> Engl.	15
<i>passerinaeformis</i> Eckl. & Zeyh.	51	<i>tephrocarpa</i> K. Schum.	11
<i>pateillicalyx</i> Engl.	42	<i>ternifolia</i> Presl	24
<i>patula</i> Harv.	54	<i>ternifolia</i> Presl ex Harv.	24
<i>paucifolia</i> Turcz.	60	<i>tigrens</i> Hochst. ex A. Rich. ("tigrensensis")	16
var. <i>chrysanthemifolia</i> (E. Mey. ex Harv.) Kuntze		<i>tomentosa</i> (Turcz.) Schinz ex Engl.	9
ex K. Schum.	60	var. <i>brevifolia</i> Engl.	9
var. <i>intermedia</i> Kuntze ex K. Schum.	60	<i>trifoliata</i> L.	24
<i>pedunculata</i> Phill.	54	<i>trifurca</i> L.	20
<i>pfeilii</i> K. Schum.	42	<i>trifurca</i> sensu Eckl. & Zeyh.	53, 55
<i>phaulochroa</i> K. Schum.	15	<i>truncata</i> Schinz	18
<i>pillansii</i> Compton	50	<i>urceolata</i> Pillans MS.	61
<i>pinnatisecta</i> Salter	58	<i>velutina</i> DC.	38
var. <i>auriculata</i> Salter	58	<i>vestita</i> Thunb.	32
<i>plicata</i> Ait.	29	<i>viscosa</i> Hiern	12
<i>plicata</i> sensu Eckl. & Zeyh.	28	<i>viscosa</i> sensu Burt Davy	11
<i>polymorpha</i> Eckl. & Zeyh.	53, 61	<i>windhukiana</i> Engl.	20
<i>praemorsa</i> Wendl.	31	<i>zeyheriana</i> Presl	58
<i>pratensis</i> Eckl. & Zeyh.	22	<i>Mahernia</i> L.	1
<i>presliana</i> Turcz.	54	subgen. <i>Mahernia</i> (L.) K. Schum.	1
<i>prismatocarpa</i> E. Mey. ex Harv.	23	<i>dryadiphylla</i> Eckl. & Zeyh.	44
<i>procumbens</i> Cav.	57	<i>hilaris</i> Eckl. & Zeyh.	20
subsp. <i>procumbens</i>	58	<i>incana</i> Eckl. & Zeyh.	20
subsp. <i>myrrhifolia</i> (Thunb.) De Wint.	58	<i>odorata</i> Andr.	38
<i>pseudo-mildbraedii</i> Dinter & Engl.	17	<i>odorata</i> sensu Eckl. & Zeyh.	38
<i>pulverata</i> Andr.	57	<i>pinnata</i> sensu Eckl. & Zeyh.	59
<i>racemosa</i> E. Mey.	18	<i>scoparia</i> Eckl. & Zeyh.	22
<i>rehmannii</i> Szyszyl.	26	var. <i>glabra</i> Eckl. & Zeyh.	22
<i>rehobothensis</i> M. Holzhammer-Friedrich	60	<i>spinosa</i> Burch. ex DC.	21
<i>repetenda</i> Verdoorn	45	<i>tomentosa</i> Turcz.	9
<i>rhopalostylis</i> K. Schum. & Schltr.	59	<i>Tricanthera modesta</i> Ehrenb.	16

Studies in the Ericoideae. III. The genus *Grisebachia*

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ABSTRACT

A revision of the genus *Grisebachia* Klotzsch in which eight species are recognized is presented. The genus belongs to the Ericaceae-Ericoideae and is endemic in the south-western part of the Cape Province. The work revealed a high degree of variability among the species, necessitating the reduction of seven species to infraspecific rank, seven species to synonymy and the rejection of one species as imperfectly known. One new species *G. secundiflora* E. G. H. Oliver is described.

RÉSUMÉ

ÉTUDES SUR LES ERICOIDEAE. III. LE GENRE GRISEBACHIA

On présente une révision du genre *Grisebachia* Klotzsch dans lequel huit espèces sont reconnues. Ce genre appartient aux Ericaceae-Ericoideae et est endémique dans le sud-ouest de la province du Cap. Le travail a mis en évidence un degré élevé de variabilité dans les espèces, ce qui a entraîné la réduction de sept espèces au rang infraspécifique; sept autres ont été mises en synonymie et une a dû être rejetée parce qu'imparfaitement connue. On décrit une nouvelle espèce, *G. secundiflora* E. G. H. Oliver.

HISTORICAL OUTLINE

When Klotzsch reclassified the subfamily Ericoideae in 1838, he described the genus *Grisebachia* consisting of eight species: *G. ciliaris* sensu Klotzsch, *G. hispida* Klotzsch, *G. involuta* Klotzsch, *G. zeyheriana* Klotzsch, *G. incana* (Bartl.) Klotzsch, *G. hirta* Klotzsch and *G. plumosa* Klotzsch. Of these, only *G. incana* and *G. plumosa* are retained in the present revision. Later in the same work he described *Eremia parviflora*, which is now recognized as a species of *Grisebachia*.

The following year Bentham (1839), when revising the whole family Ericaceae, retained *Grisebachia* but in an enlarged form. He upheld Klotzsch's eight species and added *G. dregeana* and *G. serrulata*, both of which have now been reduced to synonymy. He also included *Finkea* Klotzsch with two species, as a section. N. E. Brown (1906) correctly placed the latter in the genus *Acrostemon* of Klotzsch.

In 1876 Bentham again revised the family and included a further two of Klotzsch's genera, *Acrostemon* and *Comocephalus*, under *Grisebachia*. The genus was then divided up into three sections based on the shape of the corolla, the hairiness of the filaments and the ovary complement.

In Die Natürlichen Pflanzenfamilien Drude (1897) took a very conservative view of the Ericoideae and placed *Grisebachia* as defined by Bentham as one of four sections in the genus *Eremia* D. Don.

N. E. Brown (1906) in Flora Capensis changed the system of the earlier workers and adopted *Grisebachia* as originally construed by Klotzsch. He retained *Acrostemon* as a distinct genus and reduced *Comocephalus* and *Finkea* to synonymy under it. He retained all eight of Klotzsch's species and placed *Eremia parviflora* correctly in *Grisebachia*, but as *G. eremioides* which had been named by MacOwan in 1890. He also added ten of his own species of which only three are upheld as distinct species in the present revision, namely *G. rigida*, *G. nivenii* and *G. minutiflora*.

Phillips (1926) accepted Brown's work in its entirety in the first edition of his Genera. In 1944 he put forward his proposals for a reclassification of the family in South Africa for the second edition of his

Genera (1951). He presumably based his ideas on the very conservative views of Drude. He recircumscribed all of the genera and placed *Grisebachia* under *Eremia* together with seven other genera, some of which are quite unrelated.

The genus has been retained in Dyer's Genera (Oliver 1975) in the same form as adopted by N. E. Brown in Flora Capensis.

When the present revision was undertaken the genus *Grisebachia* consisted of 21 species. As a result of finding numerous variations and overlapping of characters the number of species has been reduced to seven. One new species, *G. secundiflora*, has been added.

MORPHOLOGY

In habit most of the species of *Grisebachia* are erect, often forming compact shrublets. *G. parviflora* is usually sparse and spreading among rocks and vegetation and *G. secundiflora* is compact but rather sprawling.

The branches of all species are never entirely glabrous. Most have pubescent to pilose or tomentose branches when young, sometimes with simple to plumose stout hairs intermingled. These may be gland-tipped.

The leaves are all typically ericoid with no open-backed forms and are mostly 3-nate. In *G. plumosa* subsp. *hispida* they are always 4-nate, while in subsp. *pentheri* they can be occasionally 4-nate inbetween 3-nate. Most leaves are adpressed with one exception, *G. ciliaris* subsp. *multiglandulosa*, where they are recurved spreading. The indumentum of the leaves is very variable and disjunctions have been used for taxonomic division. Stout simple or plumose hairs may or may not be present on the leaves and may be confined to the margins or occur on the adaxial surface as well. In many cases these stout hairs may fall off and remain only as short stubs, which can easily be overlooked.

The flowers of all species are terminal either at the ends of the main branches or more often at the ends of short lateral branchlets. In *G. parviflora* these short branchlets may be aggregated together to form a loose pseudospike and in *G. secundiflora* the pseudospike is compacted and secund. The 3-bracteolate flowers are usually 4-12 in a head or as much as 36 in *G. minutiflora*.

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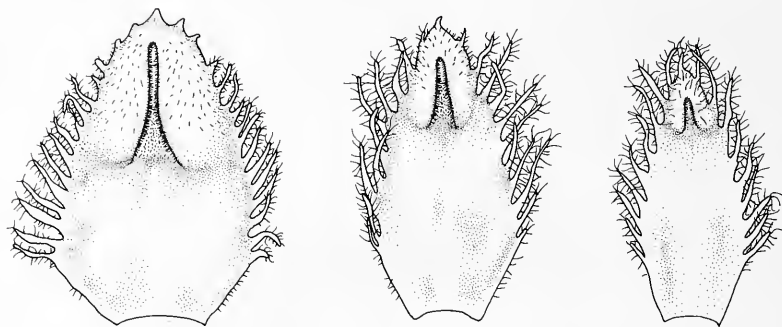


FIG. 1.—Variation in the size of the median bracteole from outer to inner flowers in a single inflorescence of *Grisebachia plumosa* subsp. *plumosa*. Drawn $\times 16$ from Thompson 791 (STE).

The bracteoles vary considerably in shape and size, particularly in *G. plumosa* and *G. ciliaris* where they are of taxonomic importance. The bracteoles may be equal to very unequal with the median bracteole being considerably enlarged with an expanded base. The variation also occurs within a single inflorescence where the bracteoles may be very unequal in the outer flowers to equal in the inner flowers (Fig. 1).

The calyx in all species is 4-lobed or 4-partite. In *G. ciliaris*, *G. incana*, *G. rigida* and *G. nivenii* the sepals are free or very slightly joined at the base, whereas in *G. plumosa*, *G. parviflora*, *G. minutiflora* and *G. secundiflora* they are joined for quarter to three quarters of their length. In all species the sepals are more or less equal. Sometimes the lateral pair may be slightly narrower than the ab- and adaxial pair. The indumentum of the calyx is very variable and is used as a taxonomic character. In most species there are some stout simple to plumose hairs on the margins of the sepals and sometimes also on the abaxial surface. These may be gland-tipped in different taxa or in the same taxon in the young stages.

The corolla is of two basic shapes in the genus. Five of the species, *G. ciliaris*, *G. plumosa*, *G. rigida*, *G. incana* and *G. nivenii*, have a corolla similar to that in the section *Cyatholoma* of the genus *Erica*. The corolla tube is more or less distinctly constricted in the middle with an ovoid or obovoid base and cyathiform upper portion including the large lobes. This is evident in the fresh state and in most of the species in the pressed material. But care must be taken with material of *G. ciliaris* subsp. *ciliaris* in which the small flowers easily lose this shape when pressed. Occasionally, when the constriction is not very marked, a campanulate shape occurs.

In the three remaining species, *G. parviflora*, *G. minutiflora* and *G. secundiflora*, the corolla has no distinct constriction. In the first two species it is usually funnel-shaped or obconic and in the third it is tubular or tubular with an inflated middle portion. In the majority of species especially those with the constricted corolla the corolla is pubescent to pilose in the middle region outside and also inside around the point of constriction.

The number of stamens in all specimens examined was constantly 4 and is important in the generic classification. The stamens are free and have pilose filaments.

The anthers are mostly manifest being arranged just above the constriction in the corolla. In *G. secundiflora* they are manifest to included. The majority of anthers are characteristically bipartite. In *G. secundiflora* there is a tendency for them to be bilobed. Awns are present in several species, but may

be absent in anthers of the same flower. This character, used in the past for specific recognition, is of no use taxonomically. The anthers are all dorsally attached with an expanded apex to the filament.

The pollen in all the material examined occurs as single grains, which are found in several of the other minor genera of the Ericoideae. The grains are tricolporate, the furrows being deeply channelled and almost as long as the cell. In shape the grains are mostly ellipsoid with flattened apices. In a few cases they are oblate as in *G. nivenii* and some forms of *G. plumosa* and *G. parviflora*. The sculpturing of the surface in the first six species is either scabrate or microscabrate with a tendency for the element rods to become fused at their distal ends to form tecta. In the last two species the fusion is complete giving an almost smooth appearance to the pollen surface (Fig. 2).

The ovary is mostly 2-celled with a single pendulous subapical ovule in each cell. Very occasionally 3-celled ovaries occur, notably in *G. parviflora* subsp. *pubescens*. In *G. secundiflora* the ovary is constantly slightly obliquely 1-celled.

Mature fruits that were found in a few species were hard-walled nuts with the walls often verrucose. They are apparently indehiscent and contain one or two very soft juicy seeds. Some fruits on *Levy's* 1367 (*G. ciliaris* subsp. *multiglandulosa*) collected in 1925 still contained soft juicy seeds.

As in most genera of the Ericoideae, the ovary in *Grisebachia* is seated on a nectariferous disc which, in some cases, is very conspicuous. This suggests that all the species are insect pollinated. On a few occasions it was noted in the field that plants were visited by bees.

The stigma varies from simple to capitellate, which is in accordance with the insect pollination.

DELIMITATION OF THE GENUS

As defined in the present revision the genus *Grisebachia* is characterized by having 3 bracteoles, 4 sepals, which are free or partly fused, a 4-lobed corolla, 4 free stamens with bipartite anthers and an ovary with 2, rarely 3 or 1, cells and a single ovule in each cell. The important characters are the stamen number and bipartite anthers.

The uniformity of the genus has until now been recorded as very constant. It has been relatively easy to assign material to the genus when identifying Ericaceae. The 2-celled ovary, 4 stamens and bipartite anthers served to be a distinctive combination of characters.

N. E. Brown recorded occasional 3-celled ovaries in *G. solivaga* and *G. nodiflora* both of which are

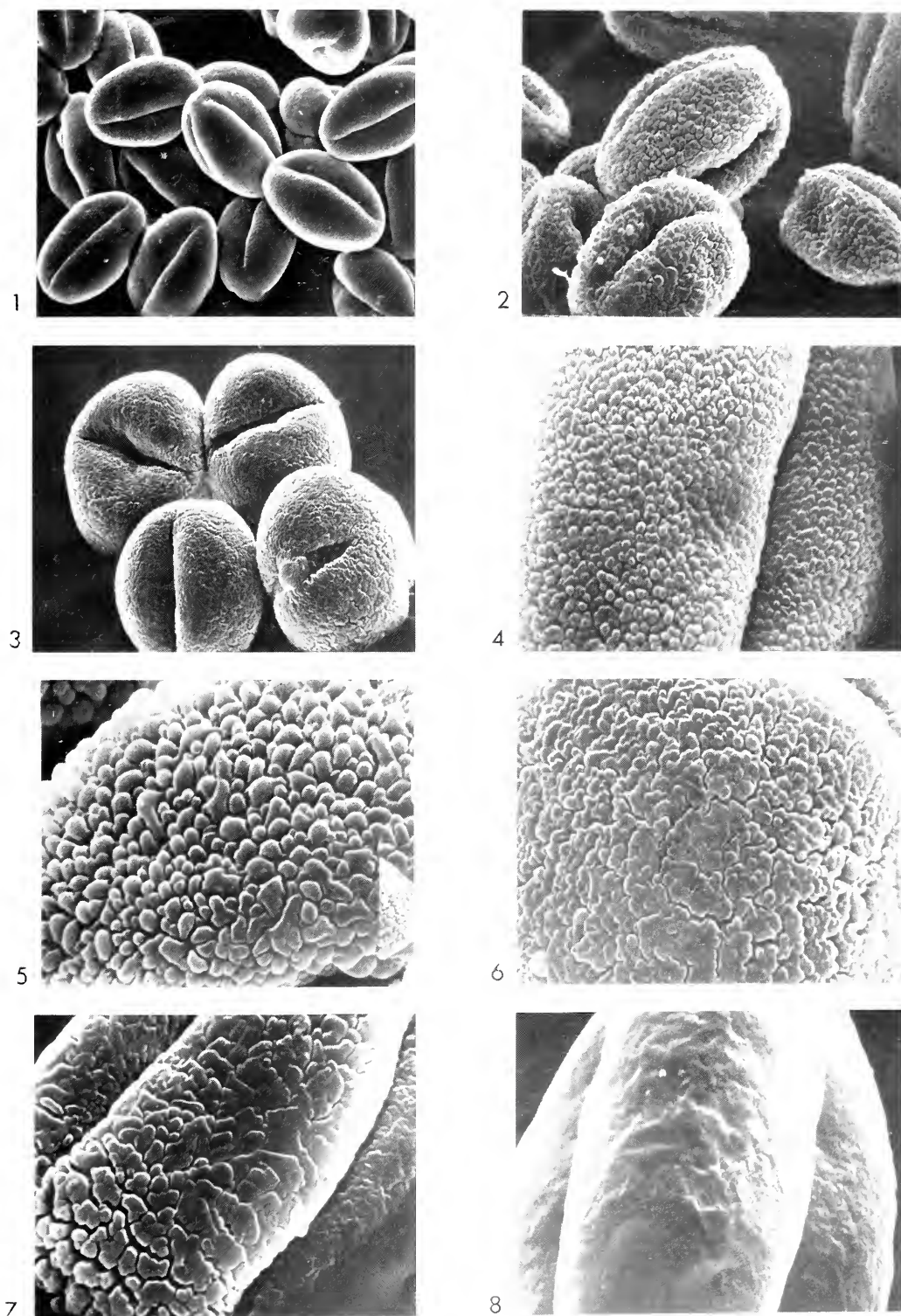


FIG. 2.—Pollen in the genus *Grisebachia*: scanning electron micrographs of pollen of various species showing the range of shapes and surface sculpturing. 1, *G. minutiflora*, $\times 1200$; 2, *G. incana*, $\times 1800$; 3, *G. plumosa* subsp. *plumosa*, $\times 1800$; 4–8, variations in surface sculpturing, all $\times 6000$; 4, microscabrate in *G. plumosa* subsp. *irrorata*; 5, scabrate in *G. rigida*; 6, microscabrate with tendency to form tecta in *G. plumosa* subsp. *plumosa*; 7, scabrate with areas large of tecta in *G. parviflora* subsp. *parviflora*; 8, smooth with complete coverage by tecta in *G. secundiflora* (cf. also surface in No. 1 above).

only known from the type collections. An examination of a few flowers did not confirm this and without investigating numerous flowers it was decided to accept Brown's observations. A number of flowers with 3-celled ovaries was, however, found in *G. parviflora* subsp. *pubescens*.

There are several genera in the Ericoideae which have 2-celled ovaries and 4 stamens, i.e. *Simocheilus*, *Acrostemon*, *Thoracosperma*, *Sympieza*, *Aniserica* and *Coilostigma*, but none of them has the distinctive bipartite anthers found in *Grisebachia*. They all have a different appearance from the rather uniform *Grisebachia*.

With the discovery of *G. secundiflora*, this uniformity was slightly changed. This species was difficult to place satisfactorily in any of the genera due to its 1-celled ovary. The species was clearly allied to some species of *Eremia* and *Grisebachia*, but could not be included in the former on the grounds of having only 4 stamens and in the latter for having a 1-celled ovary. As the genus *Eremia* has recently been emended (Oliver, 1976) to include ovary variations from 4-celled to 1-celled but with constantly 8 stamens, it was decided to place this new species under *Grisebachia* next to *G. parviflora* and emend that genus to include the 1-celled ovary rather than alter *Eremia* even further to include 4 stamens. The 1-celled ovary brought the species close to *Anomalanthus* and *Syndesmanthus*, neither of which it resembles.

The close similarity between *Grisebachia* and *Eremia* has been mentioned under that genus (Oliver, 1976). *G. parviflora* is superficially similar to *Eremia curvistyla* in flower form and habit. *G. secundiflora* looks very much like *Eremia totta* but, in both cases, the 4 stamens serve to distinguish them as species belonging to the two separate genera. The anthers of all species of *Eremia* except *E. curvistyla* are only bilobed and not distinctly bipartite as occurs in *Grisebachia*. In *Eremiella outeniquae* (Oliver, 1976) the anthers are also bipartite, but the rest of the floral characters are very different from *Grisebachia*.

Grisebachia and *Eremia* are sympatric to a great extent in the area from the Cedarberg to the Cold Bokkeveld. Undoubtedly they are very closely allied and have possibly evolved from some ancestral stock, which in turn arose from the genus *Erica* by reduction.

PHYTOGEOGRAPHY

The genus *Grisebachia* is endemic in the south-western and western parts (Fig. 3) of the Cape Province corresponding to the South-Western and North-Western Phytogeographical Centres proposed by Weimarck (1941). Most of the species occur on and west of the mountain complex of the Cedarberg, Cold Bokkeveld and Hex River and are mostly exclusive to their areas.

The commonest and most widespread species is *G. parviflora*, which occurs only on mountains from the northern Cedarberg southwards to the Villiersdorp area and eastwards to near Swellendam. It shares the central plateau of the Cold Bokkeveld with the geographically restricted species, *G. minutiflora* and *G. secundiflora*. These closely related taxa are ecologically vicarious. *G. minutiflora* is confined to sandy open flat areas.

G. ciliaris and its subspecies occur from the Nieuwoudtville plateau southwards along the east side of the Olifants River to the Porterville mountains and overlap slightly with *G. parviflora* in the northern

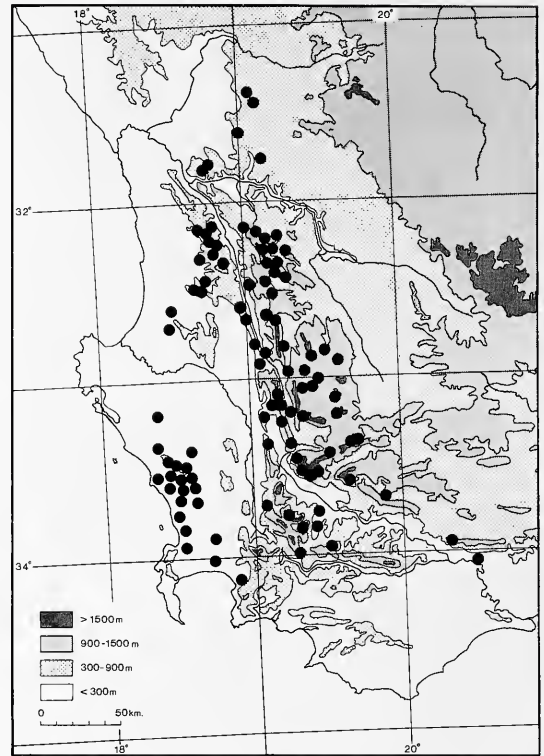


FIG. 3.—Distribution of the genus *Grisebachia*.

Cedarberg. *G. ciliaris* ssp. *ciliciflora* extends westward into the area of *G. plumosa* in Boekenberg and Lambertshoekberg. *G. plumosa* occupies the west side of the Olifants River from Clanwilliam southwards along the sandy coastal flats to the Mamre area.

Four closely related taxa are geographically vicarious. *G. ciliaris* is a northern species. *G. incana* occurs just south of the distribution range of *G. plumosa* from near Mamre to Sir Lowry's Pass. *G. rigida* is confined to the valley between Villiersdorp and Worcester and *G. nivenii* occurs isolated on the flats just south-east of Swellendam. In the same areas as the last two species there are records of *G. parviflora*, but these are from rocky higher altitude slopes.

With the exception of *G. parviflora*, which appears to be confined to rocky mountain slopes, all the species of *Grisebachia* are confined to sandy flats either on the coastal lowlands or inland on plateaux in the mountains. In many cases these sandy areas may be small and isolated and are usually alluvial being derived from rocks of the Table Mountain Series. This is very evident in the localities of *G. rigida*, *G. nivenii*, *G. minutiflora*, *G. secundiflora* and *G. ciliaris* subsp. *ciliaris*, subsp. *bolusii*, subsp. *ciliciflora* and subsp. *multiglandulosa*. The habitat of *G. ciliaris* subsp. *involuta* is not known, as details are not given on the three collections and I have not collected the subspecies, but it would probably fit the requirements.

On the lowlands of the west coast the sands are recent and alternate with the heavier clay soils of the Malmesbury beds. Here the species *G. plumosa* and

G. incana occur. The former is particularly widespread from Mamre to the Paleisheuvel area. In the north it is confined to sandy pockets in the mountains. The isolated localities of *G. incana* in the area from Mamre to Sir Lowry's Pass are ascribed to the occurrence of suitable sandy restionaceous sites. No species have been recorded from the extensive sands of the Cape Flats proper. This is probably due to the sand overlying extensive calcrete deposits.

The occurrence of *G. ciliaris* subsp. *ciliaris* on the escarpment at Nieuwoudtville in the extreme northernmost extension of more or less continuous fynbos is interesting. This feature is shared with only one other species in the minor genera, *Simocheilus klotzschianus* Benth. and a few species of *Erica*.

GRISEBACHIA

Grisebachia *Klotzsch* in *Linnaea* 12: 225 (1838); Benth. in DC., *Prodr.* 7: 700 (1839), pro parte; et in Benth. & Hook. f., *Gen. Pl.* 2: 592 (1876), pro parte; Drude in *Pflanzenfam.* 4, 1: 63 (1897), pro parte; N.E.Br. in *Fl. Cap.* 4, 1: 337 (1906); Phill., *Gen. ed.* 1, 461 (1926); E. G. H. Oliver in *Dyer, Gen.* 1: 433 (1975). Type species: *G. plumosa* Klotzsch.

Blaeria L.f. *Suppl.* 122 (1781), pro parte et auct. mult.

Erica Thunb., *Prodr.* 73 (1794), pro parte; Salisb. in *Trans. Linn Soc.* 6: 339 (1802), pro parte; Thunb., *Fl. Cap.* 364 (1823), pro parte.

Eremia Klotzsch in *Linnaea* 12: 498 (1838), pro parte; Phill. in *Jl S. Afr. Bot.* 10: 70 (1944), pro parte; et *Gen. ed.* 2, 560 (1951), pro parte.

Perennial woody shrublets, erect up to 50 cm, rarely 1 m, or compact and spreading to prostrate and spreading. *Leaves* 3-nate, rarely 4-nate, erect imbricate to spreading and recurved, pubescent often with stout subplumose to plumose hairs on the margins and abaxial surface. *Flowers* in terminal heads usually on short lateral branchlets sometimes forming congested pseudo-spikes. *Bracteoles* 3, mostly approximate, small and inconspicuous, the median sometimes large, glabrous or pubescent often with stout subplumose to plumose hairs on the margins and abaxial surface. *Calyx* 4-partite or lobed, small to enlarged and conspicuous; segments equal sometimes the laterals slightly narrower, glabrous to pubescent to crisped pilose with few to numerous conspicuous stout simple to plumose hairs on the margins and abaxial surface, the hairs sometimes gland-tipped. *Corolla* 4-lobed mostly distinctly constricted about two-thirds of the way up with an ovoid to obovoid base and cyathiform top or sometimes obconical to tubular with no constriction, mostly pubescent to pilose in the middle region and on the inside around the constriction, mostly pink otherwise white. *Stamens* 4 free, mostly manifest, rarely included. *Anthers* mostly bipartite, rarely bilobed, muticous, occasionally aristate, scabrous, with large pores. *Pollen* grains single, tricolporate, mostly ellipsoid with flattened apices rarely oblate, surface scabrate to microscabrate with element rods free to fused. *Ovary* 2-celled with a single subapical pendulous ovule in each cell, rarely 3-celled, in one species obliquely 1-celled, with a distinct nectariferous disc. *Style* exerted. *Stigma* simple to capitellate. *Fruit* a hard apparently indehiscent nut.

Key to the species

Corolla with a distinct constriction in the middle:

Sepals joined for quarter to three-quarters their length.....1. *G. plumosa*

Sepals free or slightly joined at the base:

Cilia on the calyx as long as or mostly shorter than the width of the sepal:

Sepals less than $2,0 \times 0,65$ mm.....3. *G. incana*

Sepals more than $2,0 \times 0,65$ mm:

Leaves, when young, ciliate with short gland-tipped hairs.....4. *G. rigida*

Leaves, when young, ciliate with short plumose tufts.....5. *G. nivenii*

Cilia on the calyx longer than the width of the sepal.....2. *G. ciliaris*

Corolla obconical or tubular without a distinct constriction in the middle:

Inflorescence globose, 6-36-flowered, not arranged in a pseudospike.....7. *G. minutiflora*

Inflorescence 1-4-flowered on short lateral branchlets arranged in a pseudospike:

Leaves not ciliate.....6. *G. parviflora*

Leaves distinctly ciliate with stout plumose hairs.....8. *G. secundiflora*

1. **Grisebachia plumosa** *Klotzsch* in *Linnaea* 12: 226 (1838). Syntypes: Doornhoogde on the Cape Flats, *Ecklon & Zeyher* s.n. (B†); distributed as 268 (G!; MO!; S!; W!); Doornhoogde, *Drège* s.n. (B†). Lectotype: *Ecklon & Zeyher* 268 (MO).

Compact erect shrubs up to 0,5 m, rarely 1 m, high. *Branches* numerous erect pubescent to tomentose with longer stout hairs inbetween, sometimes gland-tipped, sometimes becoming glabrous and grey. *Leaves* 3- or 4-nate imbricate and adpressed to spreading recurved, up to 4 mm long, linear-oblong to ovate, acute to obtuse, glabrous or puberulous to tomentose and canopubescent when young and with short to long stout plumose or simple eglandular or glandular hairs on the margins only or also on the abaxial surface becoming glabrous on the abaxial surface and scabrid with the stout hairs falling off leaving short truncate stubs, rarely only crisped

pubescent without any stout hairs. *Flowers* (1) 6-12 (16)-nate in terminal erect or nodding heads; pedicels short, 0,5-1,5 mm long, puberulous sometimes with longer stouter hairs inbetween, sometimes gland-tipped; bracteoles median to adpressed, markedly unequal to subequal, the median from lanceolate to broadly ovate from an expanded base, 1,5-3,5 \times 2,7 mm, the laterals usually smaller and narrower, mostly oblong-elliptic, all ciliate with short to long stout plumose to simple hairs which may be gland-tipped, with or without an even to sparse covering of similar shorter or equally sized hairs on the abaxial surface, sometimes just crisped pubescent. *Calyx* joined for one third to two thirds of its length, campanulate sometimes 4-angled at the base, pink, glabrous to pubescent with the lobes ciliate with short to long simple to markedly plumose stout to soft hairs which may be gland-tipped, occasionally with an even to sparse covering of similar shorter or

equally sized hairs on the abaxial surface; lobes narrowly to broadly deltoid, slightly sulcate at the apex. *Corolla* 4-lobed up to 4 mm long, very constricted half to two thirds the way up above an ovoid to obovoid base cyathiform above, often 4-angled the angles alternating with the calyx segments, pubescent to sparsely so in the middle region and pilose on the inside at the mouth or constriction; lobes broadly ovate to deltoid, obtuse erect to slightly spreading, glabrous or slightly pubescent down the centre outside. *Stamens* 4, free; filaments narrowly linear broadened at the point of attachment, pilose, white; anthers exserted or manifest, 0.5–1.3 mm long obovate, dorsally attached, scabrous, mucicous or rarely minutely awned the awns occurring only in a few flowers or anthers; pore about half the length of the cell; pollen grains single. *Ovary* 2-celled, compressed, ovoid to oblate, obtuse to subacute smooth to verrucose rarely pilose at the apex otherwise glabrous, seated on a disc; style exserted; stigma small, subcapitate; fruit hard verrucose. Figs 5–8.

A species forming erect shrublets up to 0.5 m occurring on sandy coastal flats in the western Cape Province from Cape Town to Graafwater and on mountain slopes in the Clanwilliam area, flowering from June to September.

G. plumosa is characterized by the calyx being joined for one quarter to three-quarters of its length, the corolla-tube being distinctly constricted in the middle and the habit being erect.

In his treatment of the genus Brown recognized five species in the group with joined calyces, basing the separation on the form of the stout hairs on the calyx. The five species were *G. plumosa*, *G. hirta*, *G. pilifolia*, *G. pentheri* and *G. solivaga*. On the small amount of material available to him this classification was feasible. But since *Flora Capensis* numerous collections of these species have been made. An examination of all this material showed a degree of variation in the diagnostic characters sufficient to warrant the five species being regarded as one single complex of taxa with discontinuities occurring only in one character and with partial separation in other characters between the constituent taxa. The oldest name applicable to this complex is *G. plumosa* Klotzsch.

It was also found that variation in the number of leaves per whorl in some specimens of *G. pentheri* overlapped with the number in the very similar *G. hispida* which had been separated off from the rest of the species in the genus on this character. *G. hispida* therefore had to be included in the *G. plumosa* Complex.

The above six taxa were then examined as one complex group. It was found that the group could be divided into two form series on the position of the stout hairs on the leaves, one with the hairs only on the margins the other with the hairs also scattered on the abaxial surface. The first series contained *G. plumosa* and *G. solivaga*, the second contained *G. hispida*, *G. pentheri*, *G. pilifolia* and *G. hirta*.

In the first form series the variation in calyx hairs from the very plumose material of *G. plumosa* in the Mamre area to the almost simple-haired specimens in the Aurora area showed an overlap with the type and only collection of *G. solivaga* from just west of Clanwilliam. Material which had been named as *G. hirta* was found to constitute a distinct new taxon more closely allied to *G. plumosa* on the leaf character. Furthermore, a collection made in the Gifberg

(Oliver 4951) was found to be nearest to *G. plumosa* and, although somewhat anomalous, was referred to this series which then consisted of *G. plumosa* (including *G. solivaga*) and the two new taxa.

In the second form series *G. pilifolia* showed considerable variation with an overlap in the distinguishing characters with *G. pentheri* thus necessitating its reduction to synonymy. A close relationship with *G. hispida* was shown to exist with only a partial separation on the number of leaves per whorl and a distinct separation in the plumosity of the hairs. *G. pentheri* and *G. hirta* appeared to be very similar with only one character showing any disjunction, i.e. the position of the stout hairs on the abaxial surface of the calyx. This series therefore consisted of *G. hispida*, *G. pentheri* (including *G. pilifolia*) and *G. hirta*.

Within these two form series recognizable on the single character difference of leaf hairs, several more or less distinct taxa could be distinguished again on various single character differences. The complex occurs in two main distribution centres, the Mamre area in the south and the mountains west of the Olifants River in the north. Regional separation of the two series in the complex is only partial. The "plumosa" series is concentrated in the south with some outliers in the far north and the "hispida" series in the north with outliers in the south.

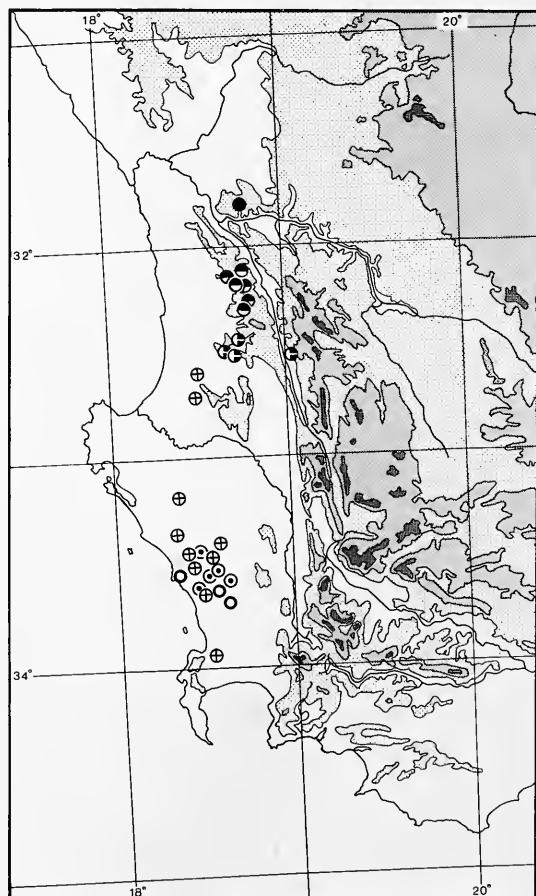


FIG. 4.—Distribution of *Grisebachia plumosa*: ⊕ subsp. *plumosa*; ⊙ subsp. *hirta*; ⊗ subsp. *irrorata*; ● subsp. *eciliata*; ⊕ subsp. *hispida*; ⊖ subsp. *pentheri*.

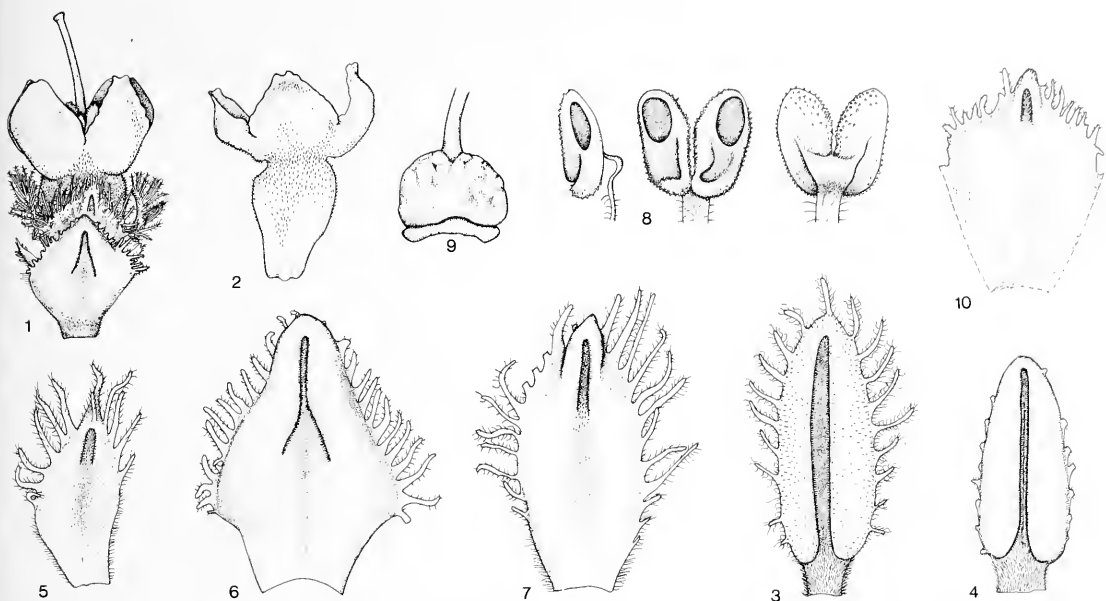


FIG. 5.—*Grisebachia plumosa* subsp. *plumosa*. 1, flower, $\times 8$; 2, corolla, $\times 8$; both from *Barker* 10388 (NBG); 3, young leaf; 4, old leaf; 5, lateral bracteole; 6, median bracteole of an outer flower; 7, median bracteole of an inner flower; 8, anther, side, front and back views; 9, ovary; all drawn $\times 16$ from the lectotype, *Ecklon & Zeyher* 268 (MO); 10, sepal, $\times 16$, drawn from *Schlechter* 8480 (PRE).

It was decided for reasons of expediency to regard the complex as one species with six subspecies based on a single character disjunction occurring with some degree of regional separation over a wide part of the distribution range of the species (Fig. 4). This classification, though not final, attempts to show the type of variation that occurs in this complex. Only a thorough biosystematic study of the populations will solve the problems and should either confirm or correct the above classification I have given.

In floral and foliage characters this is a very variable taxon in which six subspecies are recognized.

Key to the subspecies

Leaves with simple to plumose stout hairs confined to the margins or without cilia, sometimes in older leaves remaining only as short truncate setae:

Cilia simple or plumose or setae present on the leaves:

Calyx hairs eglandular.....(a) subsp. *plumosa*

Calyx hairs glandular.....(b) subsp. *irrorata*

Cilia absent on the leaves, sometimes small compound tufts present, otherwise shortly lanate.....(c) subsp. *eciliata*

Leaves with simple to plumose stout hairs on the margins and abaxial surface at least when young, sometimes in older leaves remaining only as short truncate setae:

Hairs on the leaves and calyx eglandular:

Leaves 4-nate; calyx hairs densely white plumose.....(d) subsp. *hispidula*

Leaves 3-nate rarely also 4-nate on the same branch; calyx more sparsely hairy, hairs less plumose.....(e) subsp. *pentheri*

Hairs on the leaves and calyx glandular:

Calyx hairs mostly confined to the edges of the sepals and distinctly larger than the few on the abaxial surface; bracteoles and sepals usually glabrous.....(f) subsp. *hirta*

Calyx hairs mostly of equal size and evenly distributed over the abaxial surface; bracteoles and sepals usually puberulous.....(f) subsp. *hirta*

(a) subsp. *plumosa*

G. plumosa Klotzsch in *Linnaea* 12: 226 (1838); Benth. in DC., *Prodr.* 7: 701 (1839); N.E. Br. in *Fl. Cap.* 4,1: 345 (1906). Syntypes: Doornhoogde on the Cape Flats, *Ecklon & Zeyher* s.n. (B†); distributed as 268 (G!; MO!; S!; W!); Doornhoogde, *Drège* s.n. (B†). Lectotype: *Ecklon & Zeyher* 268 (MO).

G. serrulata Benth. in DC., *Prodr.* 7: 701 (1839). Type: Giftberg, *Drège* 7802 (BM!; K!; MO!; P!; W!). *G. plumosa* var. *serrulata* (Benth.) N.E. Br. in *Fl. Cap.* 4,1: 346 (1906).

G. solivaga N.E. Br. in *Fl. Cap.* 4,1: 347 (1906). Type: Zeekoe Vlei, Clanwilliam, *Schlechter* 8480 (BM!; BOL!; E!; G!; K!; MO!; P!; PRE!; W!).

Branches pubescent to tomentose with short stout plumose hairs inbetween, rarely just tomentose. Leaves 3-nate mostly erect and adpressed, pubescent to canopubescent and ciliate with short, occasionally long, stout plumose hairs, becoming glabrous and often scabrid edged with the cilia falling off leaving short truncate setae. Bracteoles pubescent, rarely glabrous, ciliate with short stout plumose hairs, rarely also with similar hairs on the abaxial surface. Sepals pubescent, rarely glabrous, ciliate with stout plumose, rarely subplumose hairs, with a few shorter ones scattered over the abaxial surface. Fig. 5.

CAPE.—3218 (Clanwilliam): Zeekoe Vlei, 122 m (-BA/BB), *Schlechter* 8480 (BM; BOL; E; G; K; MO; P; PRE; W). S.W. of Aurora (-CB), *Barker* 9712 (NBG; STE); Aurora to Velddrif, 61 m (-CB), *Williams* 502 (BM; K); Goergap-Aurora Road (-DA), *Thompson* 791 (MO; PRE; STE); Sauer area (-DC), *Barker* 5783 (BOL; NBG; STE); *Barker* 8087 (NBG; STE); *Compton* 15488 (NBG); *Leighton* 167 (BOL; PRE); *Lewis* 3991 (SAM; STE); *Wilman* 865 (NBG; PRE). 3318 Cape Town: Hopefield (-AB), *Bachman* s.n. sub *Guthrie* 2883 (BOL; K); Darling 244 m (-AD), *Bayliss* 1663 (B; PRE); Darling (-AD), *Grant* 4604 (BM); Between Malmesbury and Darling (-AD/BC), *Hutchinson* 205 (BM; BOL; K; PRE); *Salter* 4410 (K; PRE); Mamre Road (-BC), *Barker* 5376 (NBG); *Compton* 19863 (NBG; STE); Hillslopes west of Abbotdale (-BC) *Oliver* s.n. (STE); Burgherspost, Dassenberg, 152 m (-BC), *Rourke* 500 (NBG; STE); Mamre area, flats and hills (-AD/BC/CB/DA), *Barker* 5375 (BOL; NBG); 10388 (NBG); *Compton* 6782 (NBG); 7797 (NBG); 9530 (NBG); 13883 (NBG); *Garside* 4772 (K); *Levyns* 3196 (CT); *Rycroft* 1806 (NBG; STE); *Sidey* 2289 (MO; S); *Stokoe* in SAM 62573 (SAM); Between Melk-

bosch and Mamre (-CB/DA), *Salter 1234* (BM; K; MO); 10 miles south of Mamre (-DA), *Davis s.n.* (SAM; STE); Doornhoogde on Cape Flats (-DC) *Ecklon & Zeyher 268* (G; MO; S; W).

Subsp. *plumosa* is characterized by having mostly plumose, occasionally simple, cilia on the leaf margins and no glands on the calyx. The cilia are present at least in the young stages as they often fall off leaving minute truncate setae which can easily be overlooked. This latter character was used by Benth in creating his *G. serrulata*.

This subspecies is very variable in the degree of subdivision of the stout hairs on the calyx and bracteoles. The specimens of *Bachmann s.n.* from Hopefield are very plumose. The average degree of plumosity occurs in the Mamre collections. The collections from near Aurora have glabrous calyces with simple stout cilia. These latter collections are very similar to the type and only collection of *G. solivaga* N.E. Br. from just west of Clanwilliam.

(b) subsp. *irrorata* E. G. H. Oliver, subsp. nov., a subspecie typica ciliis glandulis calyce et subspecie *hirta* similissime cilis foliorum margine solum dignoscenda.

TYPE.—Bokbaai, *Taylor 5011* (STE, holo.; PRE).

Branches pubescent becoming glabrous with short stout plumose hairs inbetween when older. *Leaves* 3-nate, adpressed but sometimes slightly recurved, pubescent becoming glabrous on the abaxial surface, ciliate with short stout plumose hairs, occasionally gland-tipped when young, sometimes falling off when older and remaining as short truncate setae. *Bracteoles* and *sepals* pubescent mainly at the apex, ciliate with simple to sparsely plumose gland-tipped hairs on the margins and slightly shorter ones on the abaxial surface. Fig. 6.1.

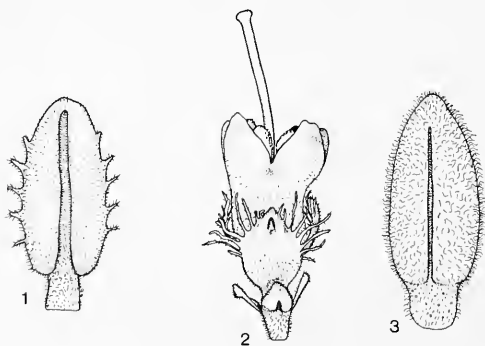


FIG. 6.—*Grisebachia plumosa*: subsp. *irrorata*. 1, leaf, $\times 16$, drawn from the holotype, *Taylor 5011* (STE); subsp. *eciliata*. 2, flower, $\times 8$; 3, leaf, $\times 16$; both drawn from the holotype, *Oliver 4951* (STE).

CAPE.—3318 (Cape Town); Bokbaai, 50 m (-CB), *Taylor 5011* (PRE; STE); near Driefontein on roadside between Philadelphia and Mamre (-DA), *Pillans 6784* (BOL); Mamre hills (-AD/BC/CB/DA), *Compton 9530* (NBG). Between Mosselbanks and Berg Rivers (-DA/DB), *Burchell 981* (K; PRE). Without precise locality: Malmesbury, from flower sellers, *Lamb 4097* (SAM). Locality unreliable: Swartberg at Caledon, *Lamb s.n.* (BOL).

Subsp. *irrorata* is recognizable by the gland-tipped hairs on the calyx and lack of stout hairs on the abaxial surface of the leaves.

Material of this taxon had been, until now, placed under *G. hirta* Klotzsch due to the key character of a glandular calyx without taking into account the

significant differences in the leaf indumentum. In subsp. *irrorata* the leaves are typical of the "plumosa" kind in which the stout hairs are confined to the margins of the leaves and do not occur on the abaxial surface as they occur in subsp. *hirta* (*G. hirta* Klotzsch).

The collection, *Compton 9530*, is intermediate between subsp. *irrorata* and subsp. *plumosa* in having glands only on the abaxial surface of the calyx. There appears to be no intermediate between this taxon and subsp. *hirta*. However, after a biosystematic study this taxon may be shown to be a hybrid between subsp. *plumosa* and subsp. *hirta*.

The three taxa, subsp. *plumosa*, subsp. *irrorata* and subsp. *hirta* are sympatric on the sandy flats of the Mamre area. These flats have unfortunately been decimated by alien vegetation and human activity. The pressure on the area from industrial and urban development is now very great.

A thorough biosystematic study of the populations from this area was not possible and probably never will be possible for a more objective assessment of their relationships.

(c) subsp. *eciliata* E. G. H. Oliver, subsp. nov., in specie foliis sine ciliis pagine abaxiali vel marginibus distinguatur.

TYPE.—Ordinansiekop, Gifberg, *Oliver 4951* (STE, holo.; BOL; K; NBG; MO; PRE; S).

Branches pubescent with simple hairs only. *Leaves* 3-nate adpressed, lanate with simple hairs, occasionally with a few tufts of stouter hairs on the margins. *Bracteoles* pubescent and lanate at the apex. *Sepals* very sparsely pilose, ciliate with irregularly and sparsely plumose hairs, rarely with a few similar hairs on the abaxial surface. Fig. 6.2, 6.3.

CAPE.—3118 (Vanrhynsdorp), Ordinansiekop on the Gifberg, 426 m (-DD), *Oliver 4951* (BOL; K; NBG; MO; PRE; S; STE).

Subsp. *eciliata* is distinct in the species for having leaves which do not possess stout hairs on either the margins or abaxial surface. The pubescence is very short, lanate and crisped. There is, however, an occasional tuft of hairs on the margins of the leaves but not similar to those found in the rest of the species.

This taxon is somewhat anomalous in that it has a similarity to *G. plumosa* complex in which the closest affinity is with the material formerly known as *G. solivaga* N.E. Br. now forming part of *G. plumosa* subsp. *plumosa*. The crisped pubescence, lack of distinct stout hairs and the tufts on the leaves are similar to the condition found in *G. ciliaris* subsp. *ciliaris* which occurs in the same area. The broad calyx lobes are similar to the broad sepals in the material formerly known as *G. dregeana* Benth. The sepals of the latter are, however, free or very slightly joined at the base.

It was decided to place this taxon under *G. plumosa* on the basis of the fused calyx segments and to leave *G. ciliaris* to be characterized by its free sepals. The taxon is, however, a close link between these two species and points to the need for a thorough biosystematic study of all the Olifants River taxa to understand their relationships.

(d) subsp. *hispida* (Klotzsch) E. G. H. Oliver, comb. et stat. nov.

G. hispida Klotzsch in *Linnaea* 12: 226 (1838); Benth. in DC., *Prodr.* 7: 701 (1839); Rach in *Linnaea* 26: 790 (1855); N.E. Br.

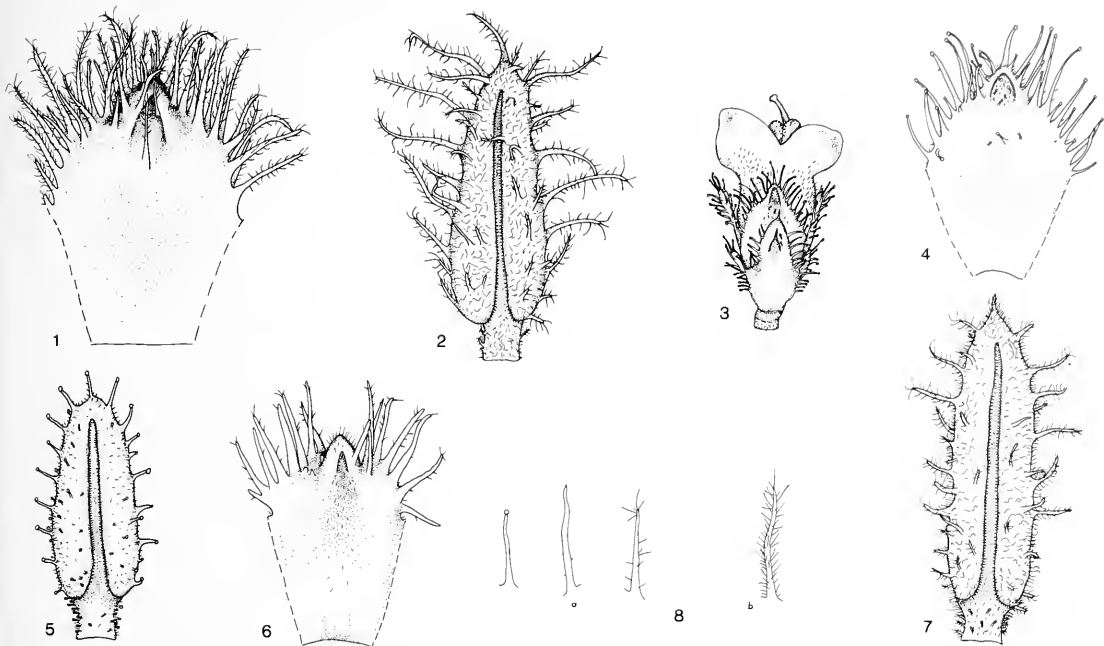


FIG. 7.—*Grisebachia plumosa*: subsp. *hispida*. 1, sepal; 2, leaf; both drawn $\times 16$, from the lectotype, Ecklon & Zeyher 267 (G); subsp. *pantheri*. 3, flower $\times 10$; 4, sepal, $\times 16$; 5, leaf, $\times 16$; all drawn from the isotype, *Penther* 2925 (STE); 6, sepal, $\times 16$; 7, leaf, $\times 16$; both drawn from *Oliver* 3869 (STE); 8, cilia variation: a, subsp. *pantheri* b, subsp. *hispida*.

in Fl. Cap. 4, 1: 339 (1906). Syntypes: near Olifantsrivier and farm Brakfontein, July, *Ecklon & Zeyher* s.n. (B†); distributed as 267 (G!; S!; W!); mountains at Winterhoek, Witsenberg and near Vogelvllei; *Ecklon & Zeyher* s.n. (B†; LD!; P!). Lectotype: *Ecklon & Zeyher* 267 (G).

Blaeria pilulota E. Mey. ex Benth. In DC., Prodr. 7: 701 (1839). Type: *Drège* s.n. (B†; isos.)

Branches pilose with numerous long stout plumose hairs inbetween. *Leaves* 4-nate, imbricate but slightly spreading, pilose, long ciliate on the edges with plumose hairs and clothed with similar hairs on the abaxial surface, often breaking off and remaining only as short truncate setae. *Bracteoles* and *sepals* pubescent, densely ciliate and clothed on the abaxial surface with long stout very plumose hairs like those on the leaves, eglandular. Fig. 7.1, 7.2.

CAPE.—3218 (Clanwilliam): Sandy uplands north of Paleisheuvel between Berg Valley and Langevallei (—BC), *Acocks* 2994 (S); Paleisheuvel (—BC), *Barker* 6719 (BOL; NBG); Boekenberg near Paleisheuvel, 549 m (—BC), *Compton* 4935 (BOL); Zwartbaskraal east of Boekenberg 300 m, (—BC), *Oliver* 3890 (B; E; K; NBG; MO; PRE; S; STE); Boekenberg 457 m (—BC), *Williams* 817 (NBG); near Zwartbaskraal, 300 m, (—BC/BD), *Drège* s.n. (BOL; K; PRE; S); between Bergvallei & Zwartbaskraal 244 m (—BC/BD), *Drège* s.n. (G—DC); Bergvallei at Zwartbaskraal 244 m (—BC/BD), *Drège* 1180 (P); Olifants River at Brakfontein, (—BD/DB), *Ecklon & Zeyher* 267 (G; S; W). Without locality: *Drège* s.n. (BM; G; P; S). Doubtful locality: 3319 (Worcester), Foot of Winterhoekseberg at Vogelvallei (—AC), *Ecklon & Zeyher* s.n. (LD; P).

Subsp. *hispida* may be distinguished by its 4-nate leaves and calyx thickly covered with densely plumose hairs. In all the material examined the leaves were 4-nate. In subsp. *pantheri* some specimens have been found to possess 4-nate leaves on branches with mostly 3-nate leaves. The subspecies has the largest leaves, flower-heads and flowers in the species.

This subspecies is very similar to some forms of subsp. *pantheri*, some of which used to constitute part of what was formerly *G. pilifolia* N.E. Br.

In these forms the calyx and leaves are eglandular and the hairs very plumose.

Subsp. *hispida* appears to be very restricted in its distribution, occurring only on the sandy hills and flats near Paleisheuvel associated with dry fynbos scrub which, according to Acocks's map of Veld Types (1953), is classified as True Fynbos and not Coastal Macchia.

(e) subsp. *pantheri* (Zahlbr.) E. G. H. Oliver, comb. et stat nov.

G. pantheri Zahlbr. in Ann. Naturh. Mus. Wien. 20: 42 (1905); N.E. Br. in Fl. Cap. 4, 1: 1128 (1909). Type: Elandsfontein, Clanwilliam, Aug. 1894, *Penther* 2925 (BM!; BOL!; STE!; W! holo).

G. dregeana Benth. var. *vestita* Zahlbr. in Ann. naturh. Mus. Wien 20: 43 (1905). Type: Olifants River valley, *Penther* 2917 (W, holo!).

G. pilifolia N.E. Br. in Fl. Cap. 4, 1: 346 (1906). Type: near Clanwilliam, *Leipoldt* 46 (BM!; BOL!; K! holo; PRE!; SAM!).

G. plumosa var. *scabra* N.E. Br. in Fl. Cap. 4, 1: 346 (1906). Type: *Thom* s.n. (BOL!)

Branches pubescent, rarely glabrous, with long stiff plumose eglandular or gland-tipped hairs inbetween. *Leaves* 3-nate, rarely also 4-nate, pubescent when young, ciliate with stout hairs and clothed with a few similar hairs on the abaxial surface, the hairs being simple and gland-tipped to plumose and eglandular, often breaking off and remaining as short truncate setae. *Bracteoles* and *sepals* mostly glabrous, rarely sparsely pubescent, ciliate with simple to plumose cilia which may be gland-tipped, occasionally clothed with a few similar shorter hairs on the abaxial surface down the middle. Fig. 7.3–7.7.

CAPE.—3218 (Clanwilliam): Uitkomst, Graafwater, 427 m, (—BA), *Compton* 4945 (BOL; NBG); 4949 (BOL); *Compton* 6789 (NBG; STE); *Compton* 24218 (NBG; STE); Kanovlei, east of Graafwater, 396 m (—BA), *Oliver* 3869 (STE); Die Berg

road (-BA/BB), *Pamphlett 103* (NBG; STE); Zeekoevlei (-BA/BB), *Pillans 7074* (BOL; K; NBG; PRE); 122 m, *Schlechter 8480* (BM; BOL; E; G; K; MO; P; PRE; STE; W); Kransvlei (-BB), *Compton 20031* (NBG); Summit of ridge south-west of Kransvlei, 640 m (-BB), *Oliver 3873* (STE); Top of Kransvlei Pass, (-BB/BD), *Lewis 2724* (SAM); Lambertshoekberg, 910 m (-BD), *Compton 5490 & 1* (BOL; NBG); *Maguire 419* (BOL; NBG); *Olyvenboschkraal* (-BD), *Leipoldt 745* (SAM); Crossroads north of Elandsfontein, 640 m (-BD), *Oliver 3879* (BM; MO; STE); Elandsfontein (-BD), *Penther 2925* (BM; BOL; STE; W); Olifants River mountains 610 m, (-BD/DB), *Schlechter 5099* (BM; BOL; K; NBG; NH; PRE). Without precise locality: Clanwilliam, *Leipoldt 46* (BM; BOL; K; PRE; SAM).

Subsp. *pentheri* is characterized by its 3-nate leaves, which are very rarely 4-nate on the same branch, its calyx which is more sparsely hairy and less plumose than in subsp. *hispida* and in the glandular form by having most of the hairs on the margins of the sepals.

This subspecies is very variable in the form of the hairs on the leaves and calyx. In *Flora Capensis* Brown recognized two separate species based on these hairs, his own *G. pilifolia* with its simple to plumose eglandular hairs and later in the addenda Zahlbruckner's *G. pentheri* with its gland-tipped simple to subplumose hairs. Since *Flora Capensis*, more material of this group has been collected and has exhibited a complete range between the two extremes thus necessitating a reduction of *G. pilifolia* to synonymy under *G. pentheri* which itself had to be reduced to subspecific rank in the *G. plumosa* complex.

The relationship between the glandular forms of subsp. *pentheri* and subsp. *hirta* is very close and it is only with some careful examination that they can be distinguished. The only character which shows any discontinuity is the distribution of the hairs on the calyx. In subsp. *pentheri* the stout hairs are mostly confined to the margins of the calyx lobes with the hairs on the abaxial surface being few and shorter. In subsp. *hirta* the hairs are more or less evenly distributed over the calyx and are of the same length. This relationship is interesting because the two taxa are widely separated.

Subsp. *pentheri* occurs frequently in scattered populations in sandy areas on the mountains on the west side of the Olifants River near Clanwilliam. Unfortunately much of the habitat of this taxon has been lost to farming practices and all that remains is in the rocky unusable areas. The fynbos in which the plants grow may without human and animal intervention become quite tall and erect plants of this taxon have been seen up to 1 m high.

(f) subsp. *hirta* (Klotzsch) E. G. H. Oliver, comb et stat. nov.

G. hirta Klotzsch in *Linnaea* 12: 226 (1838); Benth. in DC., *Prodr.* 7: 701 (1839); N.E. Br. in *Fl. Cap.* 4, 1: 345 (1906). Type: sandflats near Groenekloof, *Drège s.n.* (B†), distributed as 7795 (BM!; BOL!; E!; G!; G-DC!; HAM!; K!; MO!; P!; PRE!; W!). Lectotype: *Drège 7795* (P).

Branches pubescent to tomentose with long stiff plumose gland-tipped hairs inbetween. *Leaves* 3-nate, pubescent when young becoming glabrous, ciliate with long stout simple to plumose gland-tipped hairs and clothed with similar hairs on the abaxial surface, erect to spreading-recurved. *Bracteoles* and *sepals* puberulous sometimes sparsely so, ciliate and evenly clothed on the abaxial surface with numerous short stout simple to sparsely plumose gland-tipped hairs. Fig. 8.

CAPE.—3318 (Cape Town): 2 km north-east of Mamre (-AD), *Boucher s.n.* (PRE; STE); Mamre (-CB), *Baker 2445* (BM;

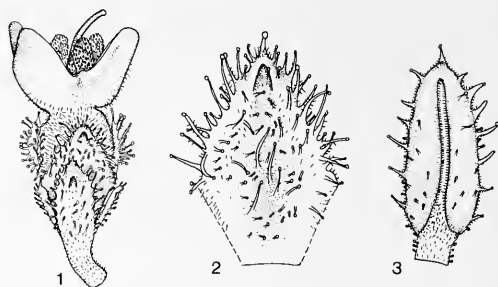


FIG. 8.—*Grisebachia plumosa* subsp. *hirta*. 1, flower, $\times 8$; 2, sepal, $\times 16$; both drawn from *Oliver 3763* (STE); 3, leaf, $\times 16$, drawn from the lectotype, *Drège 7795* (P).

K!); south of Mamre (-CB), *Barker 10388* (NBG); Silverstroomstrand Road just south of Mamre, 300 m (-CB), *Boucher s.n.* (STE); south of Mamre, (-CB) *Rycroft 2081* (NBG); 1 km north of Pella, 300 m, (-DA), *Boucher s.n.* (STE); Sandflats near Groenekloof, 60 m (-DA), *Drège 7795* (BM; BOL; E; G; G-DC; HAM; K; MO; P; PRE; W); flats just west of Pella, 228 m (-DA), *Oliver 3763* (STE); sandy north-east base of south end of Dassenberg, (-DA), *Pillans 6881* (BOL); Kalbaskraal (-DA), *Van der Merwe 14* (PRE; STE). Without locality: *Thom s.n.* (BOL); *Drège s.n.* (S).

Subsp. *hirta* is characterized by its glandular stout mostly simple hairs evenly distributed on the calyx. It differs only in this respect from subsp. *pentheri* and from subsp. *irrorata* in having gland-tipped hairs on the margins and abaxial surfaces of the leaves.

The relationship between subsp. *hirta* and subsp. *irrorata* is very close with the flowers being almost identical. The difference in the leaves, however, is distinct. In subsp. *irrorata* the leaves are typical of subsp. *plumosa* with short stout plumose cilia. As all three taxa are sympatric on the sandy flats near Mamre there is a possibility that hybridisation and introgression may occur. A thorough biosystematic study of populations from the area will have to be carried out to ascertain the relationships of these taxa.

2. *Grisebachia ciliaris* (L.f.) Klotzsch in *Linnaea* 12: 255 (1838) quoad nom., excl. descr. et spec. in herb. Willd. Type: Herb. Linn. (LINN).

Blaeria ciliaris L.f., *Suppl.* 122 (1782).

Shrublets mostly low growing and compact or erect up to 75 cm high. *Branches* subglabrous to pubescent, occasionally arachnoid, the hairs thick and matted, erect or retrorse or very sparse and erect, sometimes with stouter longer hairs inbetween which are either plumose or simple and gland-tipped. *Leaves* 4-nate, erect and adpressed, sometimes imbricate to spreading recurved, 1–4.5 mm long with the petiole very short to 0.5 mm long, from linear to ovate to obovate, very variable in the indumentum, pubescent with dense crisped retrorse hairs or puberulous with erect hairs, eciliate or rarely with small compound tufts on the margins or sometimes with stout plumose cilia with few to many spreading plume branches, the cilia often falling off and remaining as short setae, all becoming more or less glabrous with age, sometimes subglabrous to glabrous and shiny on the abaxial surface and ciliate and clothed on the abaxial surface with stout simple gland-tipped hairs. *Flowers* 3–12 in capitate, sometimes nodding, heads at the ends of lateral branchlets; bracteoles 3 subequal to markedly unequal in the outer flowers of the inflorescences to equal in the inner flowers, mostly median to remote, adpressed or recurved, the

median 1,3–5×0,45–2,3 mm, small and oblong to narrowly ovate with a relatively large keel-tip and no markedly expanded base to broadly elliptic or ovate with a broad flat base and relatively small but distinct keel-tip, from almost glabrous to puberulous all over, sometimes with a distinct apical tuft of lanate hairs, sometimes ciliate with short to long stout simple to plumose eglandular or gland-tipped hairs, rarely with a few similar hairs on the abaxial surface at the keel-tip; the pedicel 1,0–2,5 mm long, puberulous to sparsely glandular pilose. *Calyx* 4-partite sometimes slightly joined at the base, 1,5–4,3×0,4–2,3 mm, very variable in size and indumentum, small narrowly oblong to oblong-ovate to broadly elliptic or large oblong-elliptic to broadly elliptic and ovate, slightly keel-tipped occasionally with a knoblike apex, glabrous to pubescent sometimes with a distinct apical tuft of lanate or straight hairs, ciliate with long stout simple to plumose crooked or straight hairs which are eglandular or gland-tipped, plume branches long and spreading or short and erect, sometimes clothed with similar hairs on the abaxial surface, the apex devoid of cilia or ciliate, the cilia as long as, mostly longer than, the width of the sepals. *Corolla* 4-lobed, 2,5–7 mm long, constricted in the middle to two-thirds of the way up, sometimes inconspicuously so, inflated below in the lower part and often 4-angled, the angles alternating with the sepals, cyathiform above the constriction, pubescent outside mainly in the middle region, pubescent to pilose, rarely subglabrous inside around the constriction; lobes erect to slightly spreading, broadly to narrowly deltoid, smooth to slightly crenulate, obtuse, occasionally emarginate. *Stamens* 4, free; filaments mostly linear, expanded at the apex at the point of attachment to the anther, sparsely pilose to villous; anthers manifest, bipartite, 0,8–1,5 mm long, mostly oblong, scabrid to long scabrid, muticous or aristate; awns up to half the length of the cell; pore up to half the length of the cell; pollen grains single. *Ovary* 2-celled with a single ovule in each cell, mostly compressed, ovoid to oblate, obtuse, glabrous to pilose at the apex; style filiform, glabrous, far exserted; stigma subsimple to capitellate. Figs 9–16.

A species forming low compact semispreading to erect shrublets up to 0,5 m occurring in sandy areas in mountains between Porterville and Nieuwoudtville in the western Cape, flowering from August to November.

G. ciliaris is characterized by having the calyx segments free or only very slightly joined at the base, the corolla-tube more or less distinctly constricted in the middle and the cilia on the calyx longer than the width of the sepals.

G. ciliaris is one of the oldest described species among the minor genera of the Ericoideae. Strangely the species is very isolated and far-removed from Cape Town where other species more accessible existed, but were overlooked for so long. Despite its long standing, the species has been very much confused until now. Linnaeus, the younger, stated in the protologue that the species had 3-nate leaves based undoubtedly on a Thunberg specimen. Thunberg himself later published a fuller description from his own specimen stating that the leaves were 4-nate. This error was subsequently repeated by numerous authors until Rach (1853) corrected this.

A similar situation exists with *G. ciliaris* as occurs in *G. plumosa*. In Flora Capensis Brown recognized six species which he grouped on the character of a

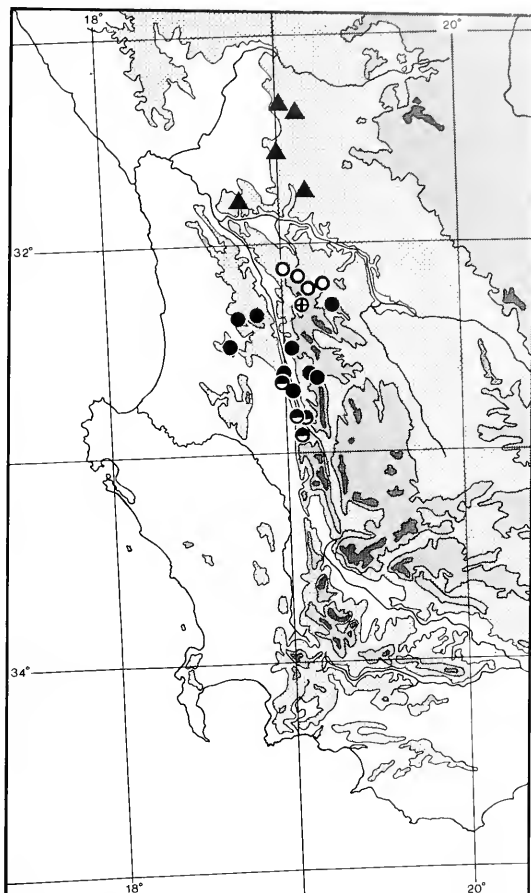


FIG. 9.—Distribution of *Grisebachia ciliaris*: ▲ subsp. *ciliaris*; ○ subsp. *bolusii*; ⊕ subsp. *involuta*; ● subsp. *ciliciflora*; ● subsp. *multiglandulosa*.

calyx divided to the base and muticous anthers. He then separated the species on the nature of the indumentum on the leaves, the sepal size and the length and form of the sepal hairs. These species were *G. bolusii*, *G. apiculata*, *G. involuta*, *G. velteriflora*, *G. dregeana* and *G. zeyheriana*. A seventh species, *G. thunbergii* (*G. ciliaris*), he characterized incorrectly by placing it with those species not having a distinctly constricted corolla. On the small amount of material available to Brown the recognition of these taxa as distinct species was feasible but numerous subsequent collections have provided a considerable degree of variation which broke down many of the existing discontinuities in the median bracteoles (Figs 10 & 11), sepal hairs (Fig. 12) and leaf glands.

It would appear that we are dealing with an aggregate species of spatially separated noninterbreeding populations which are in the first stages of evolving into a number of distinct entities which may eventually become sufficiently distinct to be regarded as separate species. At present, similarities are too close to justify this latter classification.

An important feature and character of use in delimiting the subspecies is the nature of the cilia on the calyx, something which is easily observable and yet somewhat difficult to define (Fig. 11) particularly in regard to the plume sidebranches.

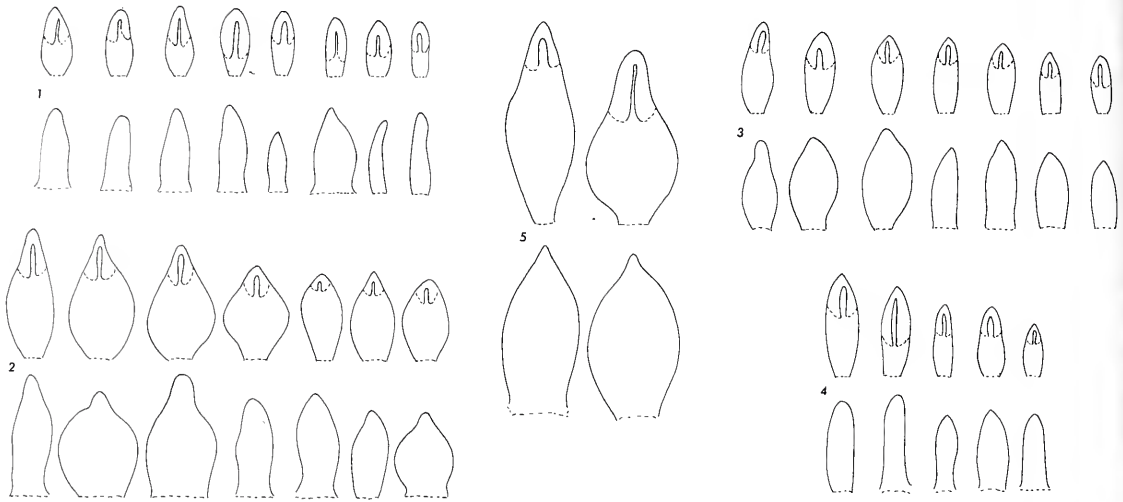


FIG. 10.—*Grisebachia ciliaris*, variation in the median bracteole (above) and sepals (below) of the outer flowers. 1, subsp. *ciliaris*; 2, subsp. *bolusii*; 3, subsp. *ciliciiflora*; 4, subsp. *multiglandulosa*; 5, subsp. *involuta*. All $\times 6$.

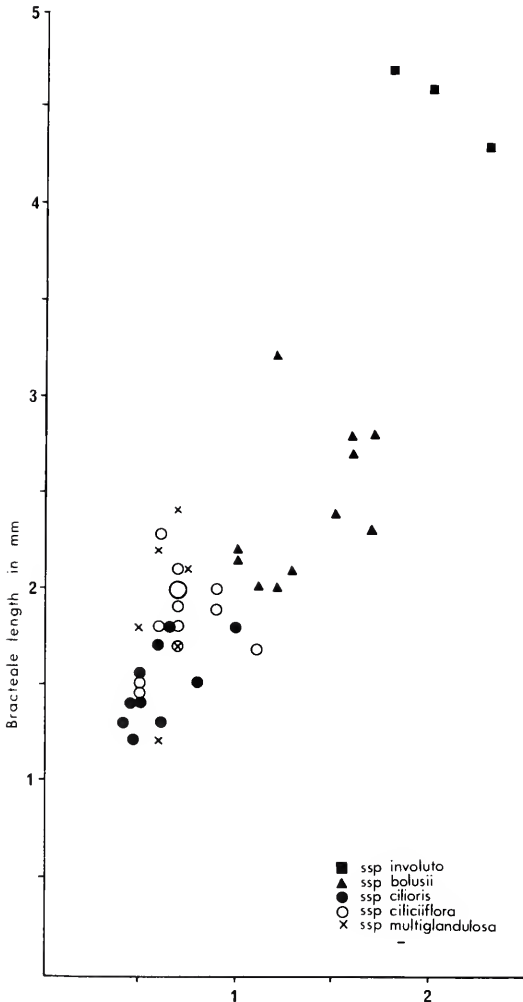


FIG. 11.—*Grisebachia ciliaris*, scatter diagram showing the variation in the median bracteole of the outer 3 flowers in a single inflorescence. Each dot represents the mean measurement of each inflorescence.

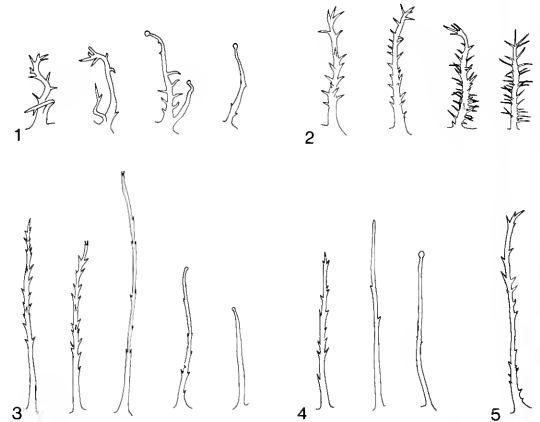


FIG. 12.—*Grisebachia ciliaris*, types of calyx cilia, all drawn $\times 16$. 1, subsp. *ciliaris*; 2, subsp. *bolusii*; 3, subsp. *ciliciiflora*; 4, subsp. *multiglandulosa*; 5, subsp. *involuta*.

G. ciliaris is confined mostly to the eastern side of the Olifants River occurring as far north as the Bokkeveld Plateau at Nieuwoudtville and the Gifberg (subsp. *ciliaris*). In the northern Cedarberg subsp. *bolusii* is confined to the Pakhuis Pass and area around Heuningvlei and Boontjieskloof with subsp. *involuta* recorded only from the Krakadouw area. Two records of subsp. *ciliciiflora* occur near Wupperthal far removed from the rest of the populations which occur in two centres, one in the Elandskloof mountains and Piekenierskloof, the other in the west on the Bockenberg and Lambertshoekberg. Subsp. *multiglandulosa* is confined to the mountains at the southern end of the main Olifants River Valley. The species seems to be specific to *Grisebachia*-type habitats namely small level open sandy alluvia mostly occurring in the mountains in isolated pockets.

G. ciliaris has several relationships with other species due to its considerable variability. The relationships lie with *G. plumosa* subsp. *pentheri* and subsp. *eciliata* and with *G. incana* and are discussed under the relevant subspecies in *G. ciliaris*.

This is a variable taxon in which five subspecies are recognized.

Key to subspecies

Bracteoles refer to the median bracteoles of the outer 3 flowers in any inflorescence

Bracteoles small up to $1,8 \times 1,0$ mm mostly $1,2 \times 0,5$ mm, mostly with a narrow base and relatively large keel-tip:

Leaves canopubescent with crisped hairs at least when young, not distinctly glandular:

Bracteoles with crisped pubescence, very rarely also with short stout hairs; calyx hairs short, simple and straight to crooked and irregularly plumose with spreading branches.....(a) subsp. *ciliaris*

Bracteoles pubescent and with distinct long plumose cilia; calyx hairs long slender, more or less straight, sparsely but evenly plumose with short forward-pointing branches.....(d) subsp. *ciliatiflora*

Leaves not canopubescent, gland-apiculate or glandular hairy:

Glands on short hairs or sessile, apical and/or marginal only.....(d) subsp. *ciliatiflora*

Glands on long hairs, apical, marginal and on abaxial surface.....(e) subsp. *multiglandulosa*

Bracteoles large, more than 2×1 mm with a broad base and relatively small keel-tip:

Bracteoles less than 3,2 mm long; sepals less than 3 mm long.....(b) subsp. *bolusii*

Bracteoles more than 4,2 mm long; sepals more than 4 mm long.....(a) subsp. *involuta*

(a) subsp. *ciliaris*

Blaeria ciliaris L.f., Suppl. 122 (1782); Willd., Sp. Pl. 1: 631 (1798); Wendl., Collect. 49 (1805); Ait., Hort. Kew ed. 2, 1: 249 (1810); Roem. & Schult., Syst. Veg. 3: 170 (1818); Klotzsch in Linnaea 8: 658 (1833); G. Don, Gen. Syst. 3: 805 (1834). Type: Herb. Linn. (LINN, holo.; K, fragm.). *Grisebachia ciliaris* (L.f.) Klotzsch in Linnaea 12: 255 (1838), quoad nom. excl. spec. in herb. Willd. no. 2890.

Erica plumosa Thunb., Prodr. 73 (1794); Salisb. in Trans. Linn. Soc. 6: 339 (1802); Schultes in Thunb. Fl. Cap. 364 (1823). Type: Thunberg no. 9393 (UPS). *Blaeria plumosa*

(Thunb.) Thunb., Diss. Blaeria 9 (1802). *Grisebachia thunbergii* Rach in Linnaea 26: 789 (1853); N.E. Br. in Fl. Cap. 4, 1: 347 (1906). Type as for *Erica plumosa*.

Grisebachia dregeana Benth. in DC., Prodr. 7: 701 (1839); N.E.Br. in Fl. Cap. 4, 1: 342 (1906). Type: Cape Colony, Drège 7803 (K, holo.; isos.).

Branches pubescent with retrorse simple hairs, sometimes arachnoid. Leaves adpressed, 1–2,5 mm long, narrowly ovate to oblong to obovate, hairy with dense crisped retrorse hairs, often becoming glabrous on the abaxial surface. Bracteoles equal to slightly unequal, median to remote, often recurved, the median $1,3–1,8 \times 0,45–0,8$ mm, narrowly ovate to elliptic to oblong with a relatively large keel-tip and no markedly expanded base, mostly pilose with crisped hairs, very rarely ciliate with a few short stout hairs; pedicel up to 1,5 mm long. Sepals 1,5–2,2 \times 0,4–11 mm, narrowly oblong to oblong to oblong-ovate, often with a swollen knob-like apex, very slightly keel-tipped, pilose at the base and sometimes in the upper half, the apex clothed with a tuft of lanate hairs, ciliate with simple to plumose stout hairs with irregular short and long spreading plume branches, eglandular or gland-tipped, cilia often crooked, as long as or longer than the width of the sepal, occasionally with some similar hairs on the abaxial surface, the apex usually devoid of cilia, rarely with cilia. Corolla up to 3,5 mm long, distinctly or indistinctly constricted in the middle, the constriction sometimes not visible in dried material, pubescent outside in the middle region, pilose to almost glabrous inside around the constriction. Anthers 0,8–0,9 mm long, scabrous, aristate rarely muticous; awns up to half the length of the cell. Ovary glabrous to pilose at the apex. Fig. 13.

CAPE.—3119 (Calvinia): Van Rhyns Pass (–AC), Barker 9427 (NBG; STE); Compton 20884 (BOL; NBG; STE); Hutchinson 763 (BM; BOL; K; PRE); 790 m, Oliver s.n. (STE); 762 m,

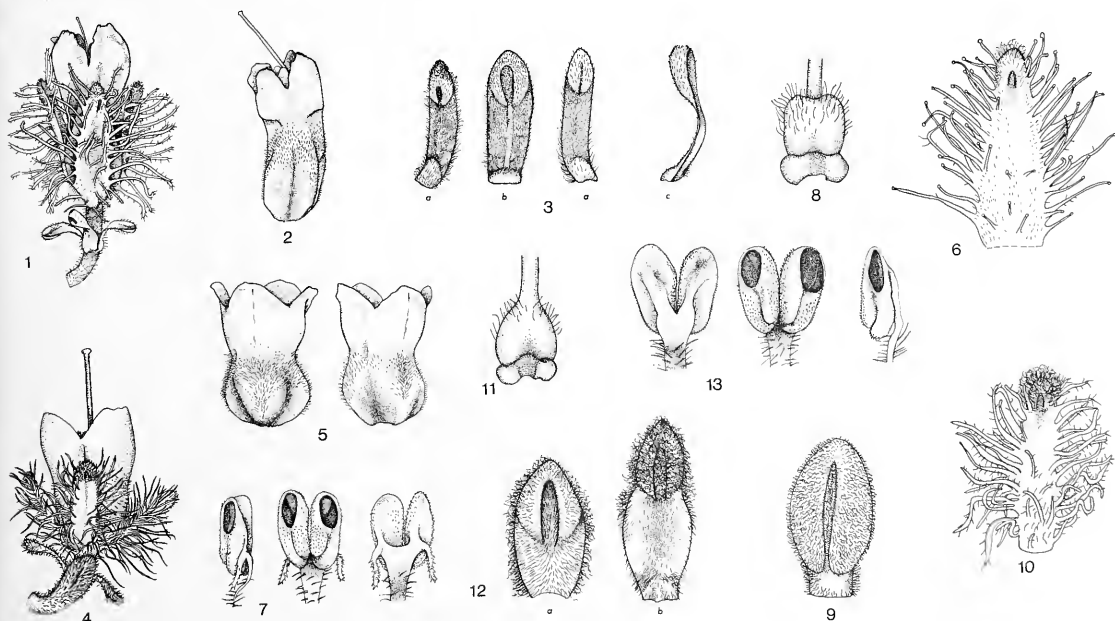


FIG. 13.—*Grisebachia ciliaris* subsp. *ciliaris*. 1, flower, $\times 8$; 2, corolla, $\times 8$; 3, bracteoles, $\times 16$: a, laterals; b, median; c, median inside view; all drawn from the fragment of the holotype (K); 4, flower, $\times 8$; 5, corolla, two views, $\times 8$; 6, sepal, $\times 16$; 7, anther, side, front and back views, $\times 16$; 8, ovary, $\times 16$; 9, leaf, $\times 16$; all drawn from Oliver 3860 (STE); 10, sepal, $\times 16$; 11, ovary, $\times 16$; both drawn from Marloth 7646 (STE); 12, median bracteoles, $\times 16$, a from Marloth 7646 (STE) and b from Middlemost 1594 (NBG); 13, anther, back, front and side views, $\times 16$, drawn from Drège 7803 (MO).

Oliver 3860 (STE; PRE); *Salter 1633* (BM; K; MO); *L. E. Taylor 2840* (NBG); Oorlogskloof, 580 m (—AC), *Lavis in BOL 19811* (BOL); Bokkeveld mountains behind farm Tabaktuin, 910 m (—AC), *Leipoldt 740* (BOL; K); Nieuwoudtville near the homestead, 910 m (—AC), *Leipoldt 741* (BOL; PRE); Glenridge, just west of Nieuwoudtville (—AC), *Lewis 5723* (NBG); 700 m, *Oliver 3864* (G; PRE; S; STE); west of Nieuwoudtville, 750 m (—AC), *Marloth 7646* (PRE; STE); *Middlemost 1594* (BOL; NBG); Willems River, 700 m (—AC), *Schlechter 10974* (BM; BOL; K; MO; STE); Lokenburg, 670 m (—CA), *Acocks 17287* (PRE); Ekerdam, Calvinia (?), *L. E. Taylor 2970* (NBG). 3118 (Vanrhynsdorp): Kobe Pass, 910 m (—DB), *Hall 4514* (NBG; STE); Gifberg near top of pass, (—DD), *Boucher s.n.* (STE); 610 m, *Oliver s.n.* (STE); Gifberg, 610 m (—DC/DD), *Drège 7803* (BOL; BOL; E; G; K; MO; P; W); *Drège s.n.* (G—DC); 910 m. *Compton 20885* (NBG); *Phillips 7585* (BOL; K; SAM). Without locality: *Thunberg s.n.* (UPS; S); *Thunberg?* (LINN; K; LU). Doubtful localities: Clanwilliam, *Bayliss s.n.* (NBG); Cedarberg Middelberg, *Leipoldt 741* (BM; BOL; K; SAM); Nortier Reserve, Clanwilliam, *Leipoldt 4365* (BOL).

This subspecies is distinguished by the canopubescens leaves, the hairs being crisped and not glandular, the crisped pubescence on the bracteoles, with rarely short stout hairs, and the relatively short calyx hairs, the hairs being simple and straight to crooked and irregularly plumose with spreading branches (Fig. 12).

Variation within the subspecies occurs in the width of the sepals where the broad form (*Lavis 19811*) merges into what was *G. dregeana* recorded as a single collection from the Gifberg. Similarly variation in the pubescence on the ovary apex and the presence or absence of anther awns provided a gradation with *G. dregeana*.

There are three groupings of populations within the subspecies. The northern group occurs on the Nieuwoudtville Plateau and has no plumes on the leaves nor cilia on the calyx apices. The two southern populations on the Gifberg and at Lockenberg are intermediates between subsp. *ciliaris* and subsp. *bolusii* in occasionally having plumes on the cilia

and a few cilia on the sepal apices. Due to the large spatial separation, a hybrid origin is ruled out. Another line of relationship occurs with subsp. *ciliciflora* of the Citrusdal area. From this latter it differs in the type of plumose sepal cilia and in having short sepal cilia. Sometimes the leaves of these two subspecies are remarkably similar in having a crisped retrorse indumentum and no cilia.

G. ciliaris (*G. thunbergii* Rach) was incorrectly assessed by Brown, who judged the corollas to be without any distinct constriction in the middle. This condition is apparent in the dried material which, when thoroughly boiled, sometimes shows a slight constriction. However, all fresh material examined possessed distinctly constricted corollas.

This subspecies is most closely related to *G. incana* from the flats near Cape Town—an unusual distributional relationship. It is distinguished by the calyx hairs being as long as or longer than the width of the sepals and, if equal, with a distinct tuft of apical crisped hairs.

(b) subsp. *bolusii* (N.E. Br.) E. G. H. Oliver, comb. et stat. nov.

G. bolusii N.E. Br. in Fl. Cap. 4, 1: 340 (1906). Type: Mountains near Pakhuis Pass, *Bolus 8681* (BOL, holo!; K!; NH!; PRE!; STE!; Z!).

Branches puberulous to pilose with simple hairs, sometimes with short stout plumose hairs admixed. Leaves extremely variable, 1,2–3,5 mm, linear-lanceolate to ovate or obovate, pubescent, sometimes with dense crisped hairs or almost lanate becoming glabrous, ciliate with stout plumose hairs or jus, compound tufts, rarely only pubescent, cilia variable mostly straight with few to many long spreading plume branches, eglandular, often falling off and remaining as stubs. Bracteoles sub-equal to very

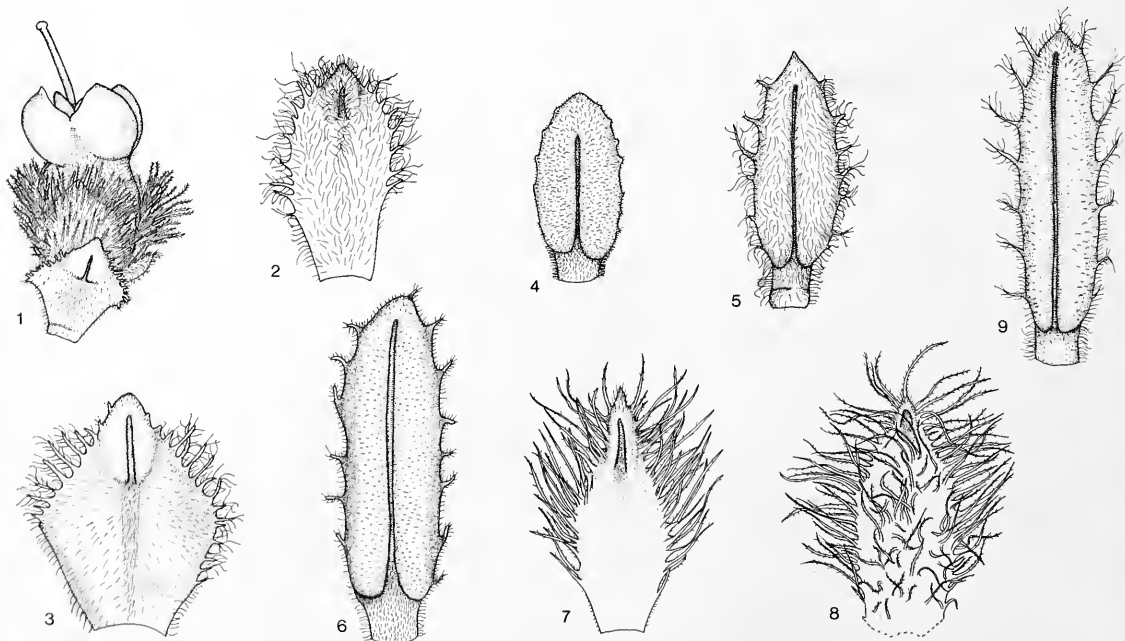


FIG. 14.—*Grisebachia ciliaris*: subsp. *bolusii*. 1, flower, ×8; 2, lateral bracteole, ×16; 3, median bracteole, ×16; 4, leaf, ×16; all drawn from the holotype, *Bolus 8681* (BOL); 5, leaf, ×16, drawn from *Compton 9634* (STE); 6, leaf, ×16, drawn from *Lewis 2725* (STE); subsp. *involuta*. 7, median bracteole, ×8; 8, sepal, ×8; 9, leaf, ×16; all drawn from *Bodkin* sub *Bolus 8680* (BOL).

unequal, adpressed to the calyx, the median elliptic to broadly elliptic or ovate, 2,0–3,2×1,0–1,7 mm, with broad flat base and relatively small but distinct keel-tip, the laterals oblong-elliptic to obovate sometimes oblique, glabrous to puberulous, ciliate in the upper half with stout plumose hairs. *Sepals* 2,1–3,0×0,9–2,0 mm, oblong-elliptic to very broadly elliptic, pubescent rarely subglabrous, ciliate with short to long stout plumose hairs, rarely subplumose, eglandular, plume branches spreading, relatively long, rarely short and erect, with similar hairs on the abaxial surface, ciliate at the apex and with an apical tuft of straight not lanate hairs. *Corolla* 3–4 mm long, pubescent to pilose inside and outside in the middle region. *Anthers* mucous rarely minutely awned. *Ovary* glabrous. Fig. 14.1–14.6.

CAPE.—3218 (Clanwilliam) (–BB) & 3219 (Wuppertal) (–AA): Pakhuis Pass, *Barker* 5622 (BOL; NBG); *Barker* 9426 (NBG); *Barker* 9426 (NBG); *Bolus* 8681 (BOL; K; NH; PRE; STE; Z); 610 m, *Compton* 4319 (BOL; NBG); 914 m, *Compton* 6864 (NBG); *Compton* 6927 (NBG); 610 m, *Compton* 7738 (NBG; STE); 760 m, *Compton* 9584 (PRE; STE); *Esterhuysen* 3225 (BOL; K; PRE; SAM); 760 m, *Esterhuysen* 23753 (BOL; STE); 610 m, *Levyns* 3937 (CT); 760 m, *Levyns* 5052 (CT; PRE); *Middlemost* 1731 (NBG; STE); *Salter* 2765 (BOL; BOL; K); 3219 (Wuppertal): Heuningvlei (–AA), *Andrag* 130 (STE); Pakhuis Pass, east slopes (–AA), *Lewis* 2725 (SAM; STE); 760 m (–AA), *Marsh* 351 (K; PRE; STE); 914 m (–AA), *Oliver* 3002 (PRE; STE); Boontjiesvlei (–AA), *Stokoe* in *SAM* 55195 (NBG; PRE; SAM); Pakhuis Pass to Heuningvlei, 960 m (–AA), *Taylor* 8537 (STE); 990 m, *Williams* 899 (NBG); Bothasberg, 600–900 m (–AA), *Thorne* in *SAM* 52644 (SAM).

This subspecies is distinguished by having a large median bracteole more than 2×1 mm but less than 3,2 mm long with a broad base and relatively small keel-tip and with marginal cilia, leaves mostly ciliate with stout plumose hairs at least when young, sepals less than 3 mm long with very plumose stout hairs with spreading branches.

This is a very variable taxon particularly as to the leaves, some being close to subsp. *ciliaris* with the short crisped indumentum and only a few tufted cilia. The majority of specimens has awnless anthers whereas those of subsp. *ciliaris* are mostly awned except in the southern populations. The bracteoles and leaves with distinct cilia serve to distinguish subsp. *bolusii*. The larger linear-leaved form tends towards subsp. *involuta*. A superficial similarity exists between subsp. *bolusii* and *G. plumosa* subsp. *pentheri* which occurs on the west side of the Olifants River valley. The free, as opposed to joined, sepals with numerous or few abaxial hairs serve to distinguish the two taxa.

Subsp. *bolusii* is very restricted in its distribution occurring only in the area around the summit of the Pakhuis Pass where, as can be expected, it has been frequently collected.

(c) subsp. *involuta* (Klotzsch) E. G. H. Oliver, comb. et stat. nov.

G. involuta Klotzsch in *Linnaea* 12: 227 (1838); Benth in *DC.*, *Prodr.* 7: 701 (1839); Drège, *Zwei Pfl. Docum.* 72 (1843); N.E. Br. in *Fl. Cap.* 4, 1: 340 (1906). Type: Boschklouf, Drège s.n. (B, holo.†; possible isos. G!; G–DC!) distributed as 7801 (BOL!; K!; P!; S!); Lectotype: Drège 7801 (K).

Branches pubescent with simple hairs. *Leaves* adpressed, up to 4,5 mm long, mostly lanceolate, straight, sparsely puberulous becoming glabrous, ciliate with short stout plumose hairs which become setae. *Bracteoles* unequal, median, adpressed to the calyx, the median 4–5×1,7–2,3 mm long elliptic to ovate with an expanded flat base and distinct keel-tip, the laterals about 3 mm long oblong with a slight keel-tip, all glabrous except for a few hairs

on the keel-tip, ciliate with long slightly plumose straight hairs, the plume branches very small and pointing towards the apex of the cilium. *Sepals* 4,3×1,9–2,3 mm broadly elliptic, slightly keel-tipped, glabrous, with apical tuft of short straight hairs, ciliate with long straight slightly plumose hairs, plume branches very small and pointing towards the apex of the cilium. *Corolla* 6–7 mm long, constricted two-thirds of the way up, pubescent in the middle region outside, villous inside at the constriction. *Anthers* about 1,5 mm long, mucous, scabrous. *Ovary* glabrous. Fig. 14.7–14.9.

CAPE.—3219 (Wuppertal): Krakadouw (–AA), *Bodkin* sub *Bolus* 8680 (BM; BOL; K; PRE; STE); Boschklouf at the foot of Blaauwberg, 300–600 m (–AA), Drège 7801 (BOL; K; P; S); Drège s.n. (G–DC); Pakhuis mountains (–AA), MacOwan 3268 (SAM).

This subspecies is characterized by its overall larger flowers and inflorescence, the bracteoles being longer than 4,2 mm and the sepals longer than 4 mm, both with a broad base and relatively small keel-tip.

The larger size is the only differentiating character between this subspecies and some forms of subsp. *bolusii*. It also has close similarities with some forms of subsp. *ciliatiflora* but, again, the size difference is pronounced and the bracteole shape slightly different. The sepal cilia (Fig. 12) are more closely related to those of subsp. *ciliatiflora* than those of subsp. *bolusii*.

Subsp. *involuta* is very restricted in its distribution possibly occurring in only one or two populations on the western side of the Krakadouw range. No recent collections have been made. These populations are allopatric to those of subsp. *bolusii* and subsp. *ciliatiflora* making interchange of genetic material highly improbable.

(d) subsp. *ciliatiflora* (Salisb.) E. G. H. Oliver, comb. et. stat. nov.

Erica ciliatiflora Salisb. in *Trans. Linn. Soc.* 6: 339 (1802). Type: Hottentots-Holland, Masson s.n. (BM, holo!). *Blaeria ciliatiflora* (Salisb.) G. Don, *Syst. Veg.* 3: 805 (1834). *G. ciliatiflora* (Salisb.) Druce in *Rep. Bot. Soc. Exch. Club Brit. Isl.* 1916: 625 (1917).

G. velleriflora Klotzsch in *Linnaea* 12: 227 (1838); Benth. in *DC.*, *Prodr.* 7: 701 (1839); N.E. Br. in *Fl. Cap.* 4, 1: 341 (1906). Type: between Twenty-four Rivers and Olifants River, Drège s.n. (B, holo.†; P!).

G. zeyheriana Klotzsch in *Linnaea* 12: 227 (1838); N.E. Br. in *Fl. Cap.* 4, 1: 342 (1906). Type: near Olifantsriver and Farm Brakfontein, Ecklon & Zeyher s.n. (B, holo.†) distributed as 269 (G!; K!; LU!; MEL!; MO!; P!; S!; SAM!; W!).

G. apiculata N.E. Br. in *Fl. Cap.* 4, 1: 341 (1906). Type: mountains near Pienkies Kloof, Schlechter 4969 (K, holo!; BM!; BOL!; G!; P!; PRE!; S!; STE!; W!; Z!).

Branches pubescent with erect to retrorse short simple hairs. *Leaves* adpressed, 1,5–3,0 mm long, linear to ovate, mostly pubescent with adpressed crisped hairs becoming somewhat glabrous on the abaxial surface, rarely glabrous when young, occasionally ciliate with short stout gland-tipped hairs or just apiculate. *Bracteoles* remote or median, unequal to subequal, slightly recurved, 1,4–2,3×0,5–0,8 mm, oblong to elliptic, the laterals linear to linear-elliptic, with a distinct keel-tip and flat base, pubescent to subglabrous but with an apical tuft of crisped hairs, ciliate with long stout subplumose hairs; pedicel long pilose. *Sepals* 1,6–2,5×0,6–1,3 mm, oblong to broadly elliptic with a slight keel-tip pubescent to glabrous with or without an apical tuft of straight hairs, ciliate with long straight plumose hairs, plume branches small forward pointing, rarely subplumose, rarely gland-tipped. *Corolla* 2,5–3,0 mm long, distinctly constricted and 4-angled

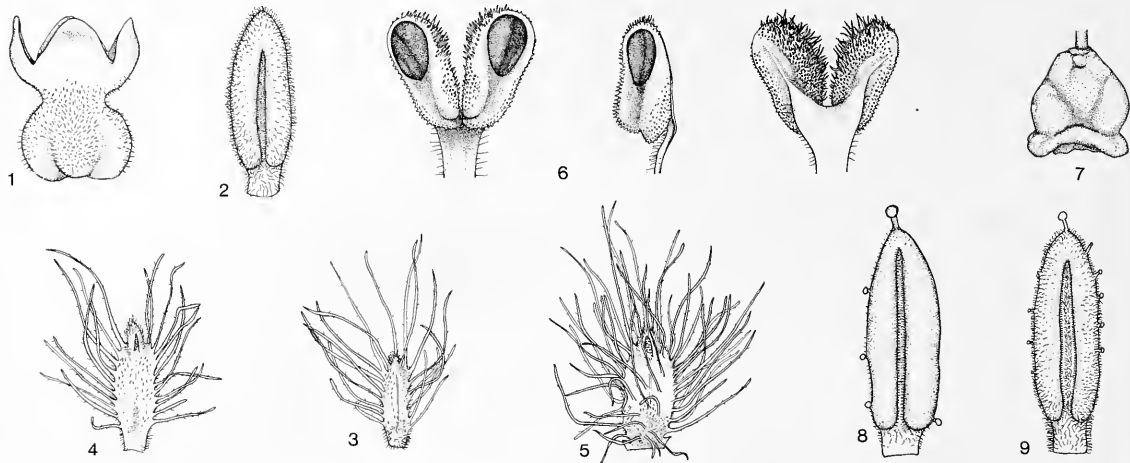


FIG. 15.—*Grisebachia ciliaris* subsp. *ciliciflora*. 1, corolla, $\times 8$; 2, leaf, $\times 16$; both drawn from Oliver 4017 (STE); 3, lateral bracteole, $\times 8$; 4, median bracteole, $\times 8$; 5, sepal, $\times 8$; 6, anther, front, side and back views, $\times 16$; 7, ovary, $\times 16$; all drawn from the holotype, Masson s.n. (BM); 8, leaf, $\times 16$, drawn from Stokoe in SAM 54847 (STE); 9, leaf, $\times 16$, drawn from Schlechter 4969 (STE).

at the base, pubescent to pilose outside and inside in the middle region. *Anthers* about 1 mm long, mucous long scabrous; pore half the length of the cell. *Ovary* glabrous. Fig. 15.

CAPE.—3218 (Clanwilliam): Between Berg and Lang Valley (—BC), *Acocks* 2995 (S); Boekenberg, 548 m (—BC), *Compton* 4947 (BOL); Alexandershoek, 90–120 m (—BC/BD), *Schlechter* 5127 (BM; BOL; K; P; PRE; SAM; STE; W; UPS; Z); Lambertsboekberg, 910 m (—BD), *Compton* 5492 (BOL; NBG); Between Witelskloof & Lambertsboekberg, (—BD), *Pillans* 9057 (BOL; K; PRE); Piekenierskloof, 365 m, (—DB), *Schlechter* 4969 (BM; BOL; G; K; P; PRE; S; STE; W; Z). Without precise locality: Clanwilliam, *Leipoldt* 213 (BOL; K; PRE; SAM); Clanwilliam, *Mader* 181 (BOL; K), 3219 (Wuppertal); Citadelkop near Wuppertal (—AA), *Compton* 24264 (NBG; STE); Brakfontein, 300 m (—AC) *Adamson sub Levyns* 1320 (CT); by the Olifants River and near Brakfontein, (—AC), *Ecklon & Zeyher* 269 (G; K; LD; MEL; MO; P; S; SAM; W); Elandsloof, 610 m (—CA), *Compton* 5325 (BOL; NBG); 1370 m, *Compton* 16128 (NBG; STE); *Compton* 20965 (BOL; NBG; PRE; STE); *Leipoldt* in BOL 21655 (BOL); *Stokoe* in SAM 54847 (SAM; STE); Elandsloof Pass, (—CA), *Häfstrom & Acocks* 1043 (PRE; S; STE); Waterfall between Citrusdal & Elandsloof, (—CA), *Stokoe* 7712 (BOL; NBG; NH; PRE); *Williams sub Baker* 1821 (BM); Kleinfontein east of Citrusdal 762 m, (—CA), *Oliver* 4019 (E; K; MO; P; PRE; STE); Allandale, south-east of Citrusdal, 548 m (—CA), *Oliver* 5007 (BM; G; S; STE); near Citrusdal (—CA), *Rust* s.n. (STE); Warmbaths to Modderfontein, (—CA), *Stephens* 7042 (BM; BOL; K; SAM); between Twenty-four Rivers and Olifants River, 300 m (—CC/3319 AA), *Drège* 1179 (P). Without locality: *Drège* s.n. (BM; BOL; G; K; MO; W); *Forsyth* s.n. (BOL; K); *Masson* s.n. (BM; G—DC).

This subspecies is characterized by the small usually subequal narrow-based bracteoles with conspicuous long plumose cilia and by the leaves, when glandular, with the glands apical or marginal only and usually short-stalked to sessile and by the sepals with long plumose hairs having very small erect branches.

Relationships with the other subspecies are in three directions and are somewhat difficult to explain in the case of subsp. *ciliaris* due to the geographical isolation of the latter. The relationships with subsp. *involuta* and subsp. *multiglandulosa* are understandable due to the reasonably close proximity of the populations.

There is considerable variation within this subspecies which necessitated the inclusion of *G. apiculata* and *G. zeyheriana* in the synonymy. The typical form of subsp. *ciliciflora* possesses leaves with a

crisped, sometimes retrorse, indumentum and calyx with numerous long sparsely plumose hairs with plume branches forward pointing. In some forms the leaves possess sessile or subsessile marginal glands and a large apical gland.

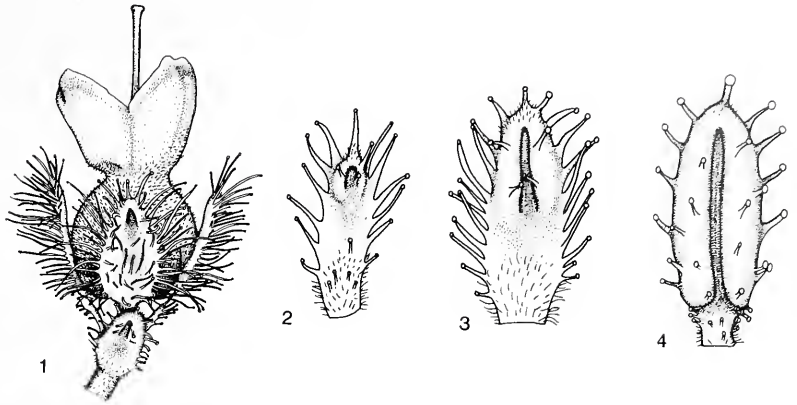
Subsp. *ciliciflora* occurs in the Citrusdal area mostly at lower altitudes on sandy open patches and on the mountains north-west of the town. The locality near Wuppertal, *Compton* 24264, is unusual and inexplicable.

(e) subsp. *multiglandulosa* E. G. H. Oliver, subsp. nov., similis subspecie *ciliciflorae*, sed distinguatur pilis longis glandulis marginibus et paginis abaxialibus foliorum bracteolarumque.

TYPE.—Cape, Olifants River Valley above Toorgat on the farm Grootfontein, *Oliver* 3972 (STE, holo. !; K!; MO!; NBG!; PRE!).

Branches puberulous to subglabrous with stouter gland-tipped hairs admixed. *Leaves* recurved-spreading sometimes straight and adpressed, 1.5–4.5 mm long with petiole 0.5 mm long, lanceolate to ovate mostly glabrous and shiny on the abaxial surface and sparsely puberulous on the adaxial surface, rarely entirely glabrous, occasionally puberulous all over when young, ciliate and clothed on the abaxial surface with short to long stout simple gland-tipped hairs, sometimes those on abaxial surface falling off in erect leaves. *Bracteoles* median to remote, subequal to unequal, 0.8–2.5 mm long the laterals mostly 1.0 mm long, linear to oblong-ovate to oblong-elliptic with an enlarged keel-tip, glabrous to pilose in the lower half, sometimes crisped at the apex, ciliate with stout gland-tipped simple hairs with a few on the keel-tip; pedicel up to 2.5 mm long, sparsely puberulous with simple and gland-tipped hairs. *Sepals* 1.9–2.5 \times 0.5–0.8 mm oblong to oblong-ovate with a slight keel-tip, glabrous, rarely with a few scattered hairs, ciliate with long straight subplumose to simple hairs with similar hairs on the abaxial surface, hairs often gland-tipped. *Corolla* about 4.5 mm long, distinctly 4-angled, pubescent below the constriction sometimes sparsely so and confined to the angles, villous inside. *Anthers* about 0.8 mm long, scabrous, mucous. *Ovary* glabrous. Fig. 16.

FIG. 16.—*Grisebachia ciliaris* subsp. *multiglandulosa*. 1, flower, $\times 8$; 2, lateral bracteole, $\times 16$; 3, median bracteole, $\times 16$; 4, leaf, $\times 16$; all drawn from the holotype, Oliver 3792 (STE).



CAPE.—3218 (Clanwilliam): Grey's Pass, 457 m (—DB), *Levyns* 1367 (CT; SAM). 3219 (Wuppertal): Olifants River Valley, Keerom (—CC), *Esterhuysen* 17889 (BOL); east slope of Grassuggens, 640 m (—CC), *Oliver* 3992 (STE); *Pillans* 8785 (BOL; PRE; STE); Olifants River Valley above Toorgat on Grootfontein, 548 m (—CC), *Oliver* 3972 (K; MO; NBG; PRE; STE); Grootfontein, Ratel River, 426 m (—CC), *Oliver* 3987 (E; PRE; STE); Porterville mountains, Berghof, 790 m (—CC), *Oliver* 3934 (BM; G; NBG; PRE; STE; Z); 3941 (K; STE; W).

This subspecies may easily be recognized by its leaves which are erect to recurved-spreading mostly glabrous but with distinct long gland-tipped hairs on the margins and abaxial surface, by its small bracteoles up to $1,8 \times 1,0$ mm which have stout subplumose to simple hairs on the margins and abaxial surface of the keel-tip and by the simple to subplumose eglandular or gland-tipped hairs on the sepals.

The material available varies somewhat in floral and foliage characters. The leaves are always gland-ciliate with long stout hairs on the margins and abaxial surface and are mostly distinctly recurved-spreading. But a few specimens have erect adpressed leaves like those of subsp. *ciliciiflora*. The calyx cilia may be simple or occasionally plumose with plume branches like those in subsp. *ciliciiflora*. It was found that the only distinguishing character is the presence of abaxial hairs on the leaves and bracteoles in subsp. *multiglandulosa*.

Subsp. *multiglandulosa* is confined to the mountains at the southern end of the main Olifants River valley where it occurs mainly on sandy open flat areas. The majority of populations is allopatric to those of subsp. *ciliciiflora*, occurring at high altitude only. In the region of Pienekierskloof there is, however, an overlap. The specimen, *Levyns* 1367, is an intermediate very similar to the type and only collection of *G. apiculata* (subsp. *ciliciiflora*). Unfortunately all the populations appear to have been removed in this area by agriculture thus making a study of the populations impossible.

3. *Grisebachia incana* (Bartl.) Klotzsch in Linnaea 12:225 (1838); Benth in DC., Prodr., 7:701 (1839); N.E. Br. in Fl. Cap. 4, 1:344 (1906).

Blaeria incana Bartl. in Linnaea 7: 650 (1832). Type: On flats below Tigerberg at Rietvallei, *Ecklon* s.n. (B, holotype; P). Lectotype: *Ecklon* s.n. (P).

G. alba N.E. Br. in Fl. Cap. 4, 1: 344 (1906). Type: without locality, *Grey* s.n. (K!).

Small compact shrublets to 30 cm high. Branches pubescent to tomentose with reflexed hairs, occasionally with stout plumose to gland-tipped sub-

plumose hairs in between. Leaves 3-nate adpressed, 1,5–2,0 mm long, elliptic to oblong-obovate, pubescent becoming glabrous on the abaxial surface, ciliate with a few very short stout plumose hairs or with short stout gland-tipped hairs; petiole very short, pubescent, sometimes with gland-tipped hairs. Flowers in small terminal heads of 3–6 (9) on the ends of lateral branchlets, pink, occasionally white; pedicel up to 1,0 mm long pubescent; bracteoles subequal to unequal, median but adpressed, 1,0–1,4 mm long, narrowly oblong to elliptic oblong often with an enlarged keel-tip, acute or obtuse, the laterals linear, pubescent, ciliate with short stout plumose hairs or subplumose gland-tipped hairs. Calyx 4-partite; lobes $1,2\text{--}1,8 \times 0,3\text{--}0,65$ mm, mostly narrowly oblong, occasionally elliptic-oblong or linear, acute, pubescent with longer straight hairs at the apex, ciliate with stout plumose eglandular hairs to ciliate with stout subsimple gland-tipped hairs, all shorter than the width of the lobe, sometimes with similar but shorter hairs on the abaxial surface. Corolla 2,4–2,7 mm long, constricted at the middle, ellipsoid below, urceolate above, pilose to villous in the middle region and slightly up the back of the lobes, pilose inside around the constriction; lobes very broad, obtuse, erect-spreading. Stamens 8, free; filaments linear, much dilated at the point of attachment, sparsely pilose; anthers manifest, about 0,7 mm long with oblong parallel to spreading cells, scabrid edged, aristate; awns small to obsolete, arising from the apex of the filaments, scabrid; pore relatively small about one quarter the length of the cell. Ovary 2-celled with a single pendulous ovule in each cell, compressed, broadly ovoid, pubescent on top and seated on a distinct nectariferous disc; style filiform, glabrous, far exerted; stigma simple to capitate. Fruit a hard verrucose nut. Figs 17 & 18.

A species forming small compact shrublets occurring in sandy places on the flats between Sir Lowry's Pass, Kraaifontein and Mamre, flowering early from April to July.

CAPE.—3318 (Cape Town), Flats east of Melkbosch (—CB). *Pillans* 6671 (BOL; K); Between Melkbosch and Mamre (—CB/DA), *Salter* 792 (BM; K); Groenkloof (—DA), *Ecklon & Zeyher* 266 (G; MEL; MO; W); Mamre road near Melkbosch-strand road (—DA), *Levyns* 9402 (CT); Mamre turnoff southwest of Olifantskop, 76 m (—DA), *Oliver* 3753 (STE); Koeberg, Baasariesfontein, 168 m, (—DA), *Oliver* 3756 (STE); Melkbosch, 7 km from the sea, (—DA), *Wasserval* 167 (K; NBG; PRE); Rietvallei (—CD/DC), *Ecklon* s.n. (P); Kraaifontein, 15–30 m, (—DA), *Dümmer* 1553 (E); Gravel pits near Kraaifontein, (—DA), *Esterhuysen* 18638 (BOL; NBG; PRE); Brackenfell (—DA), *Galpin* 12679 (K; PRE; W); Scotsville, Kraaifontein

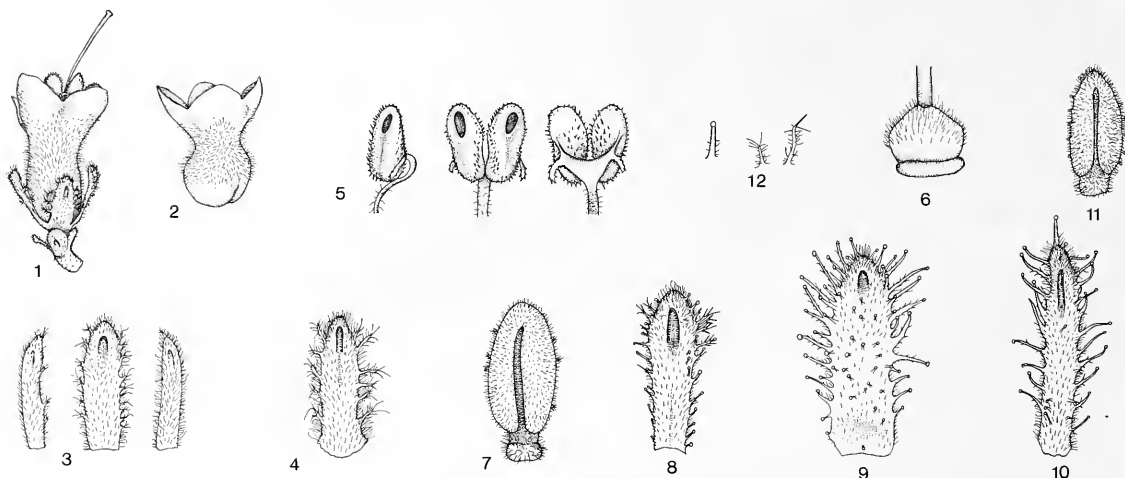


FIG. 17.—*Grisebachia incana*. 1, flower, $\times 8$; 2, corolla, $\times 8$; both from Oliver 3750 (STE); 3, bracteoles, $\times 16$; 4, sepal $\times 16$; 5, anther, side, front and back views, $\times 16$; 6, ovary, $\times 16$; all drawn from the lectotype, *Ecklon* s.n. (P); 7, leaf, $\times 16$, drawn from Oliver 3750 (STE); 8, median bracteole, $\times 16$; 9, sepal, $\times 16$; both drawn from Oliver 3746 (STE); 10, sepal, $\times 16$, drawn from *Stokoe* 6062 (BOL); 11, leaf, $\times 16$, drawn from Oliver 3746 (STE); 12, variation in the hair types on the sepals, $\times 16$.

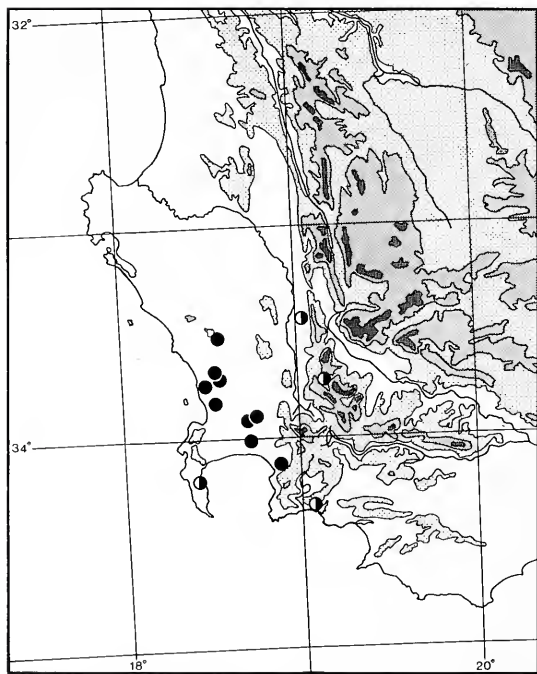


FIG. 18.—Distribution of *Grisebachia incana* (● are doubtful localities).

(-DA), *Markotter* s.n. (STE); Koopmanskloof between Bottelary and Kraaifontein (-DA), Oliver 3746 (STE); 3747 (STE); Base of Tygerberg (-DA), Pillans in BOL 17726 (BOL); Brackenfell (-DA) *Salter* 4395 (BM; BOL; K); Kraaifontein (-DA), *Strey* 479 (PRE); Old Tygerberg (-DA), *Zeyher* s.n. (SAM; PRE); Penhill Estate, Eersterivier, (-DC), *Raitt* s.n. (STE); Between the Cape Flats and Stellenbosch, (-DC/DD), *Burchell* 8344 (BOL; K; M; P; PRE; W). 3418 (Simonstown), Sir Lowry's Pass, 305 m, (-BB), *Lamb* 4091 (SAM). Without locality: Cape Town Flower Show, *Stokoe* 6062 (BOL; K; NBG; PRE); *Admiral Grey* s.n. (K); *Lehmann* s.n. (K); *Mund & Maire* s.n. (E; G; K; P; W). Doubtful localities: Vogelvllei, *Ecklon & Zeyher* s.n. (HAM; LU; P; UPS; Z); Dutoitskloof, *Erège* 8689 (BM; E; K; W); Hills behind Simonstown, *Lamb* 3223 (BOL; SAM); Kleinmond, *Leipoldt* s.n. (BOL; NBG; P); mountains near Swellendam, *Mund* s.n. (BOL; K).

G. incana may be distinguished from related taxa by its small flowers, small narrow sepals less than 2.0×0.65 mm which have slender straight cilia as long as but mostly shorter than the width of the sepal and by the straight hairs forming the apical tuft on the bracteoles and sepals.

The species affords a good example of geographical vicarism with its closely related species which are well separated spatially, e.g. *G. ciliaris* subsp. *ciliaris*, *G. rigida* and *G. nivenii*.

Difficulty was experienced in distinguishing *G. incana* from *G. ciliaris* subsp. *ciliaris*. The former occurs only on the sandy coastal flats adjacent to the Cape Peninsula, whereas the latter is confined to the summits of mountains around Vanrhynsdorp and Nieuwoudtville.

N. E. Brown unfortunately misinterpreted the corolla shape in *G. ciliaris* subsp. *ciliaris* and so isolated it from *G. incana* in his revision. Several characters were examined in detail and found to have a certain degree of disjunction and, when used in combination, served to distinguish the two taxa. In *G. incana* the leaves possess hairs which are mostly erect as opposed to the crisped retrorse hairs in *G. ciliaris* subsp. *ciliaris*. The leaves are usually edged with short stout plumose hairs or gland-tipped hairs, whereas in *G. ciliaris* subsp. *ciliaris* this rarely occurs. The calyx in *G. incana* is mostly pilose with a tuft of longer straight hairs at the apex and with cilia shorter than the width of the sepal. In *G. ciliaris* subsp. *ciliaris* the calyx is very sparsely puberulous with a distinct apical tuft of long interwoven crisped hairs and with cilia longer than the width of the sepal.

To the east there occur two closely related species, *G. rigida* and *G. nivenii*, both in restricted separate areas. *G. incana* differs from both these species in the size of the sepals, which are less than 2.0×0.65 mm, and in the texture and indumentum of the leaves. In the glandular form of *G. incana* the leaves are very similar to those in *G. rigida* but are not so inflated, are more pubescent and have the glands confined to the margins.

The sepals in this species are the smallest and narrowest in the genus; in one specimen being only

0,3 mm wide. This feature makes the corollas more easily visible than in other species. The anthers are unique in the genus in having the smallest pores relative to the size of the cell.

Two fairly distinct forms occur in the material so far collected. The specimens from the north around Mamre have bracteoles and sepals with more plumose cilia which are eglandular. Those from the south in the Kraaifontein area have sub-plumose gland-tipped hairs on the sepals, bracteoles and on the leaves. This variation is, however, clinal with no distinct disjunction between the two extremes.

N. E. Brown described *G. alba* from a single collection made by Admiral Grey and based it on the single character of white flowers including the anthers. White-flowered forms of *G. incana* have been collected, but these have had pale brown anthers. In all other characters, *G. alba* is identical to the glandular form of *G. incana* and is presumed to be only an aberrant albino of this species.

G. incana is fairly restricted in its distribution occurring only on the recent sand deposits on the coastal flats at Sir Lowry's Pass, Eerste River, Kraaifontein, below Tygerberg and near Melkbosstrand. The records from Simonstown, Kleinmond, du Toit's Kloof and Vogelvlei are very doubtful.

4. *Grisebachia rigida* N.E. Br. in Fl. Cap. 4, 1:343 (1906). Syntypes: near Brand Vley, *Schlechter* 9926 (BM!; BOL!; Z!); mountains between French Hoek and Villiersdorp, *Bolus* 5193 (BOL!; K!; PRE!; Z!). Lectotype: *Bolus* 5193 (K).

Shrublets compact and low to erect up to 50 cm high. Branches pubescent with simple recurved hairs, very occasionally gland-tipped, rarely with stout plumose hairs admixed. *Leaves* 3-nate up to 3,0×1,0 mm, mostly elliptic to narrowly elliptic,

occasionally ovate or oblong-obovate, thick and fattened, pubescent or minutely scabrous on the abaxial surface, rarely glabrous and shiny, pubescent on adaxial surface, ciliate with 7-9 short stout gland-tipped hairs and with some scattered over the abaxial surface, petiole very short, shortly glandular pubescent. *Flowers* 1-8-nate on the ends of lateral branchlets, pink, rarely white; pedicels about 1 mm long, pubescent with some plumose hairs at the apex; bracteoles equal to slightly unequal with the median slightly broader, adpressed to the calyx, ovate to oblong-ovate to elliptic to narrow oblong-elliptic, obtuse, glabrous or sparsely pubescent, ciliate with stout simple to very slightly plumose hairs which are mostly gland-tipped, rarely sparsely pilose inside, keel-tipped. *Calyx* 4-lobed, slightly joined at the base; lobes ovate-elliptic to oblong-elliptic to broadly elliptic up to 2,1-2,8×0,9-2,0 mm, often with incurved margins, subacute, keel-tipped, glabrous or sparsely pubescent mostly in the lower half, ciliate with broadly based stout hairs almost fimbriate in places and with similar hairs up the centre of the abaxial surface, hairs mostly simple or very slightly plumose, rarely gland-tipped, often crooked. *Corolla* up to 4,4 mm long often oblique, distinctly constricted in the middle; tube up to 3 mm long globose ellipsoid, spreading above the constriction, 4-angled, puberulous outside with glabrous patches opposite the sepals, pilose on the inside mainly at the point of constriction; lobes erect-spreading slightly crenulate and emarginate about 1 mm long, very broadly obtuse, pubescent at the base in the middle. *Stamens* 4; filaments linear, sparsely to densely pilose, up to 2,5 mm long; anthers manifest, attached dorsally one third the way up, variable in size, 0,7-1,1 mm long with oblong to obovate parallel or spreading cells, almost glabrous to scabrous, occasionally with some long transparent hairs on the edges, muticous

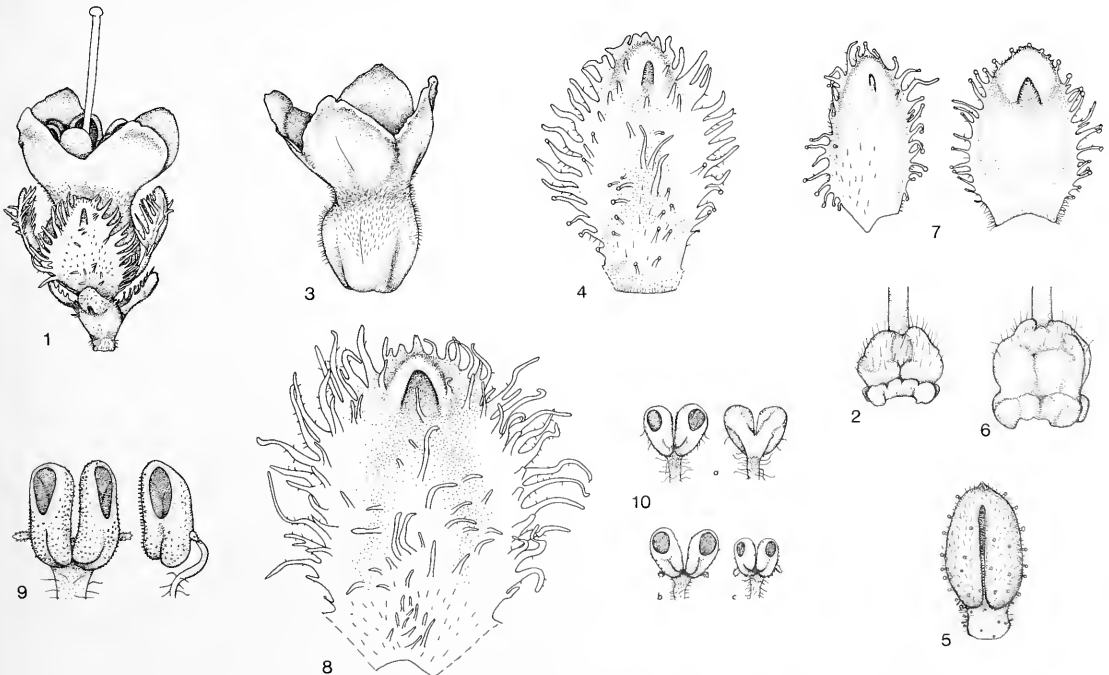


FIG. 19.—*Grisebachia rigida*. 1, flower, ×8; 2, ovary, ×16; both drawn from Oliver 3297 (STE); 3, corolla, ×8; 4, sepal, ×16; 5, leaf, ×16; 6, ovary, ×16; all drawn from Oliver 3299 (STE); 7, bracteoles, lateral and median, ×16; 8, sepal, ×16; 9, anther, front and side views, ×16; all drawn from an isotype, *Bolus* 5193 (BOL); 10, anther variation drawn ×16: a, *Oliver* 3297 (STE); b, *Salter* 4784 (BOL); c, *Van Breda* 628 (PRE).

or aristate; awns up to 0,4 mm long or one third the length of the cell, arising from the filament apex, spreading laterally to descending, minutely scabrous; pollen grains single. *Ovary* 2-celled with a single pendulous ovule in each cell, $0,6 \times 0,8-0,9 \times 0,9$ mm, broadly ovoid to ellipsoid, compressed, obtuse, variously pilose at the apex, very unevenly wrinkled; style up to 4 mm long, glabrous, exserted; stigma slightly capitate. *Fruit* a hard verrucose nut. Fig. 19.

CAPE.—3319 (Worcester), south-west end of Brandvlei, 213 m, (—CB), *Oliver* 5038 (STE); near Brandvlei, 304 m, (—CB), *Schlechter* 9926 (BM; BOL; Z); Brandvlei Kelders, (—CB), *van Breda* 628 (B; PRE); between Worcester and Villiersdorp (—CB/CD), *Compton* 22918 (NBG); flats north-east of Wabooms Farms, 200 m (—CD), *Oliver* 3299 (STE); Kwaggaskloof near Moordkuil, 200 m (—CD), *Oliver* 3297 (MO; PRE; STE); 13 miles north of Villiersdorp (—CD), *Salter* 4784 (BM; BOL; K; SAM); Doornrivier, 304 m (—CD), *Walters* 1012 (K; PRE; STE); mountain slopes between Villiersdorp and French Hoek (—CC/CD/ 3419 AA/AB), *Bolus* 5193 (BOL; K; PRE; Z). Flowers from August to October.

G. rigida is characterized by its free or slightly joined sepals which are more than $2,0 \times 0,65$ mm with very broad flattened subplumose or simple cilia and by its fattened leaves which are ciliate with short gland-tipped hairs and with a few similar hairs on the abaxial surface.

The species differs from *G. nivenii* in the leaf cilia, less plumose calyx and glabrous inner surface of the sepals. It is closely related to *G. incana* from which it is easily distinguished by its broader sepals with their broad cilia and by the leaves.

G. rigida varies in the size of the sepals where in the type, *Bolus* 5193, they may be as much as $2,7 \times 2,0$ mm. The anthers also vary in size, shape and in the occurrence of awns. A few specimens have anthers with long colourless hairs, a feature very rarely seen in the Ericoideae.

The species occurs on the recent sandy alluvial flats at the eastern base of the Stettyns Mountains between Worcester and Villiersdorp where isolated pockets of fynbos grow (Fig. 20). The surrounding area possesses mountain renosterveld on the shales and Wittenberg quartzites. In this area the species is very susceptible to extinction due to encroaching agriculture and burning.

Bolus's record between French Hoek and Villiersdorp has not been reconfirmed. Although somewhat removed from the main populations and coming from a completely different valley system, this record could be correct due to the numerous sandy alluvial patches in the area.

5. *Grisebachia nivenii* N.E. Br. in Fl. Cap. 4, 1:343 (1906). Syntypes: Hottentots-Holland, ?*Niven* 128 (BOL!; K!); near Zondereinde River, *Gill* s.n. (K!); near Swellendam, *Mund* 3 (K!; PRE!). *Lectotype*: ?*Niven* 128 (K).

G. ciliaris Benth. in DC. Prodr., 7: 701 (1839), non Klotzsch. Type: in prov. Swellendam occidentali, collector not cited.

Shrublets compact, erect, up to 50 cm high. *Branches* minutely pubescent with retrorse hairs. *Leaves* 3-nate, adpressed, up to $1,7 \times 1,2$ mm, broadly ovate to elliptic, very rounded and thick, obtuse or acute, glabrous on the abaxial surface, pubescent on the adaxial surface, ciliate with 5–6 short stout plumose cilia; petiole very short and broad, ciliate. *Flowers* in terminal globose heads of 3–8 on the ends of lateral branchlets, pink, rarely white; pedice's very short, sparsely pubescent, sometimes with stout plumose hairs at the apex; bracteoles adpressed,

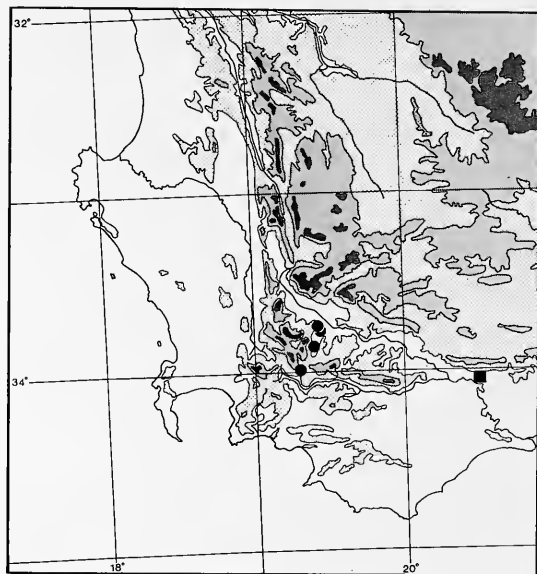


FIG. 20.—Distribution of ● *Grisebachia rigida* and ■ *Grisebachia nivenii*.

about 1,3 mm long, subequal, rarely markedly unequal, mostly oblong-elliptic sometimes the laterals obliquely so, the median rarely angular-ovate, all keel-tipped, obtuse or acute, puberulous outside and inside, ciliate with stout plumose hairs. *Calyx* 4-lobed, sometimes slightly joined at the base; lobes broadly elliptic to narrowly oblong-elliptic, $2,1-2,9 \times 0,65-1,3$ mm, acute, keel-tipped, puberulous on the abaxial surface mainly towards the base, sparsely puberulous on the inside, ciliate with stout broad plumose hairs with similar hairs over the adaxial surface towards the centre, rarely gland-tipped. *Corolla* up to 4,0 mm long, sometimes oblique, distinctly constricted in the middle; tube up to 3 mm long, globose ovoid to ellipsoid, urceolate above the constriction, pubescent to pilose in the middle and lower part and up the back of the lobes and inside the tube around the constriction; lobes broadly obtuse, erect or slightly spreading. *Stamens* 4; filaments linear, sparsely to densely pilose; anthers manifest, about 0,8 mm long, oblong, dorsifixed one third of the way up, papillate, aristate; pore about a third of the length of the cell; awns small, spreading to deflexed, arising from the filament at the point of attachment to the anther; pollen grains single. *Ovary* 2-celled with a single pendulous ovule in each cell, $0,7-0,6$ mm, ovoid compressed, obtuse sparsely pilose at the apex; style exserted, up to 4 mm long; stigma capitate or subsimple. *Fruit* verrucose, hard. Fig. 21.

A species forming compact erect shrublets up to 50 cm high occurring in a very restricted area of sandy flats south-east of Swellendam, flowering from July to September.

CAPE.—3420 (Bredasdorp), Bontebok National Park, 90 m (—AB), *Acocks* 22371 (PRE; STE); 100 m, *Barnard* 583, (STE); 581 (PRE), 100 m, *Liebenberg* 6464 (B; PRE; STE); 90 m, *Oliver* 1519 (NBG; STE); *Oliver* 4305 (STE); 4306 (NBG; PRE; STE); sandy places near Swellendam, 180–240 m (—AB), *Mund* 3 (K; PRE); Buffeljagsrivier (—BA), *Zeyher* 3330 (SAM). Without precise locality: Zondereinde River, *Gill* s.n. (K). Doubtful locality: Hottentots-Holland, alpine rock places *Niven* or *Masson* 128 (K). (cf. Fig. 20).

G. nivenii may be recognized by its very fattened shiny adpressed leaves which are glabrous on the

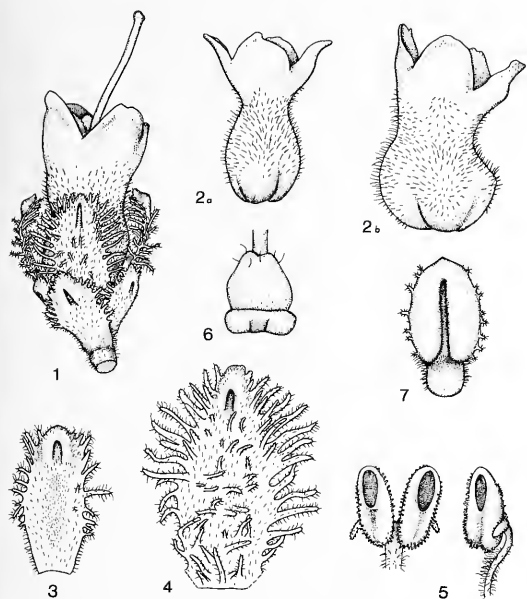


FIG. 21.—*Grisebachia nivenii*. 1, flower, $\times 8$; 2, corolla variation, $\times 8$; all drawn from Oliver 4305 (STE); 3, median bracteole, $\times 16$; 4, sepal $\times 16$; 5, anther, front and side views, $\times 16$; all drawn from the lectotype, *Niven* 128 (K); 6, ovary, $\times 16$; 7, leaf, $\times 16$; both drawn from Oliver 4305 (STE).

abaxial surface and have 5–6 very short stout plumose cilia and by its more or less free sepals which have short stout flattened plumose cilia.

The species is closely allied to *G. rigida* and *G. incana*. It differs from *G. rigida* in having glabrous shiny leaves, even when young, with plumose cilia and no gland-tipped cilia. The calyx cilia are more plumose than in *G. rigida* and there is a sparse pubescence on the inside of the sepals. From *G. incana* it differs in leaf details, the latter having pubescent nonfattened leaves. The sepals in *G. nivenii* are broader, more than 2.0×0.65 mm.

G. nivenii is geographically isolated as it occurs only on the sandy flats in the hilly country south-east of Swellendam where it is far removed from its closest allies, *G. rigida* and *G. incana*. Like nearly all the other species in the genus it is confined to a few small patches of alluvial sand. The surviving populations in the area now lie within the boundaries of the Bontebok National Park.

There is some confusion about the collector of the lectotype of the species. It was labelled as “C.B.S. Masson” but N. E. Brown changed this to *Niven*. The handwriting is definitely not *Niven*’s, but matches that on the type of *Eremia brevifolia* Benth. which Brown cited as collected by Masson. Neither of these labels exactly matches the handwriting of Masson in the Kew Archives. Brown labelled this sheet as the type.

Variation within the species is very slight. The sepals in *Zeyher* 3330 are somewhat narrower than in the other specimens and have some gland-tipped hairs.

The *G. parviflora*/*G. minutiflora* group

Along the main chain of mountains and high level plateaux running in a north–south direction

from the Cedarberg through the Cold Bokkeveld to the Worcester District, there is a series of vicarious taxa. Superficially they are very similar in their low compact to spreading habit, small white sub-calcine to calycine flowers, manifest anthers and ciliate calyx lobes.

One very variable taxon (A) is widespread from the Cedarberg to the mountains south of Worcester and eastwards to near Swellendam, occurring on dry stony slopes with short dry restiad/ericoid vegetation. It usually forms a low compact to sprawling shrublet with branches spreading amongst the restiads. It consists of three distinct allopatric vicariads and has had the names *G. parviflora* (Klotzsch) Druce (*G. ermioides* MacOwan) and *G. similis* N.E. Br. applied to it.

The second taxon (B) is much more restricted, occurring in the central and southern Cold Bokkeveld on dry open sandy flats and forms a low compact shrublet sometimes slightly sprawling and rooting at the nodes. This has had the names *G. minutiflora* N.E. Br. and *G. nodiflora* N.E. Br. applied to it. As with the taxon A, there are two distinct allopatric vicariads in this taxon.

To my knowledge the two taxa only grow in reasonably close proximity in the Hartebeeskloof and Winkelhaak areas where I have observed them. In the former locality the plants of taxon A (*G. parviflora*) were few and were outliers of the larger populations higher up the rocky slopes. The plants of taxon B (*G. minutiflora*) were locally common on open sandy patches. In the latter locality taxon B was flowering three months later than the early flowering vicariad of taxon A.

The main morphological difference between these two taxa lies in the form of the inflorescence. In A the flowers are generally 1–4-nate at the ends of short axillary branchlets which are often clustered together in a pseudospike along the main and lateral branches. In B the flowers are terminal on the ends of short branchlets with up to 36 flowers forming a cluster. These clusters usually hang downwards making the plants less conspicuous than those of taxon A. Except for one vicariad, plants of taxon B are glandular particularly on the margins of the calyx. The glands terminate plumose cilia. In taxon A the few glands are confined to the short simple cilia on the calyx.

Taking into account the habitat and morphological differences, I have decided to regard the two taxa A & B as closely related species referred to *G. parviflora* and *G. minutiflora* respectively and to recognize several subspecific taxa.

6. *Grisebachia parviflora* (Kotzsch) Druce in Rep. Bot. Soc. Exch. Club Brit. Isl. 1916: 625 (1917). Type: Hills between Puspas Valley and Kogmansklouf mountains, *Ecklon & Zeyher* s.n. (B \dagger , holo.; isos.?). Neotype: flats between Witsenberg and Skurfdeberg, *Zeyher* 1117 (K!, neo.; BOL!; G!; SAM!; STE!; W!).

Low compact to spreading shrublets up to 20 cm high, rarely up to 50 cm. Branches erect or spreading often entwining among the surrounding vegetation, with numerous short branchlets, pubescent sometimes with glands admixed. Leaves 3-nate up to 3 mm long with the petiole, erect to spreading, straight to markedly recurved, linear to lanceolate rarely ovate, acute, flat to trigonous, glabrous or at first puberulous, ciliate sometimes with gland cilia or sessile glands, sometimes gland-apiculate: petiole adpressed ciliate.

Flowers 1-4-nate at the ends of extremely short branchlets arranged in a spike-like manner along the branches; pedicels very short, less than 0.5 mm long; bracteoles 3, equal to subequal, adpressed to the calyx or slightly spreading, very variable in size, up to 1.5 mm long, in shape from linear to elliptic-oblong to ovate, acute to obtuse, glabrous or pubescent ciliate with or without sessile or stalked glands white. *Calyx* 4-lobed for $\frac{1}{2}$ - $\frac{3}{4}$ its length, campanulate 0.6-1.8 mm long and 0.3-0.8 mm wide, glabrous or pubescent, white; lobes erect variable in shape from elliptic-oblong to ovate to subquadrate, the apex acute cuspidate or subtruncate with an apiculus, with or without a distinct keel-tip and with or without a distinct median ridge, ciliate, with or without sessile or stalked glands. *Corolla* 4-lobed, up to 3×1.7 mm long, mostly 2×1.2 mm, funnel-shaped sometimes broadening more above the middle, nowhere constricted, occasionally tubular-ellipsoid; tube glabrous inside sometimes glabrous outside or puberulous in lower half to fully pubescent; lobes erect to incurved, rarely slightly spreading, obtuse, broader than long, glabrous entire. *Stamens* 4 included or manifest; filaments filiform glabrous; anthers up to 1.1 mm long with oblong parallel separate cells, basal, minutely scabrous, aristate; awns $\frac{1}{3}$ - $\frac{1}{2}$ the length of the cell to rudimentary, ciliate; pore $\frac{1}{3}$ - $\frac{1}{2}$ the length of the cell, pollen grains single. *Ovary* 2-celled with a single ovule per cell in one subspecies, rarely 2 ovules per cell and sometimes 3 cells, ovoid to ellipsoid, up to 1×0.7 mm, obtuse glabrous to puberulous on the top, sometimes thickly pubescent; style far exserted, straight or curved, glabrous up to 4 mm long; stigma minutely capitate. Figs 22 & 23.

A species generally low, sparse and sprawling in habit, occasionally compact, occurring frequently on dry stony slopes and flats on mountains from the Cedarberg to Du Toit's Kloof eastwards to near Swellendam, flowering from as early as July to as late as January.

A very variable taxon in which three subspecies are recognized.

Key to the subspecies

Leaves erect to spreading, straight or slightly curved, calyx lobes acute to obtuse:

Corolla tube glabrous or puberulous in the lower $\frac{3}{4}$, calyx usually glabrous.....(a) subsp. *parviflora*

Corolla tube pubescent all over, calyx pubescent.....
.....(c) subsp. *pubescens*

Leaves markedly recurved, calyx lobes subquadrate, subtruncate.....(b) subsp. *eglandula*

(a) subsp. *parviflora*

Eremia parviflora Klotzsch in Linnaea 12: 488 (1938); N.E. Br. in Fl. Cap. 4, 1: 334 (1905). *Grisebachia parviflora* (Klotzsch) Druce in Rep. Bot. Soc. Exch. Club Brit. Isl. 1916: 625 (1917).

Erica shalliana Hort. Berol. ex Klotzsch in Linnaea 12: 498 (1838), nom. nudum.

Grisebachia eremioides MacOwan in J.Linn. Soc. 25: 392 (1890); N.E. Br. in Fl. Cap. 4, 1: 349 (1906); Compton in J. S. Afr. Bot. 1: 151 (1935). Syntypes: Witsenberg and Houw Hoek Zeyher 1117, near Tulbagh Waterfall, MacOwan 2685 (SAM!); MacOwan sub Herb. Norm. 564 (BM!; BOL!; G!; K!; P!; PRE!; SAM!; UPS!; W!).

G. eremioides var. *pubicalyx* N.E. Br. in Fl. Cap. 4, 1: 349 (1906). Type: Mountains of Tulbagh Kloof, Bolus 5304 (BOL!; K!; PRE!; SAM!).

G. similis N. E. Br. in Fl. Cap. 4, 1: 350 (1906). Type: Cold Bokkeveld, Schlechter 8896 (BOL!; K!; numerous isos!).

G. similis var. *grata* N.E. Br. in Fl. Cap. 4, 1: 350 (1906). Type: Cedarberg, near Sneekup and Wuppertal, Bodkin sub Bolus 8628 (BOL!; PRE!).

Low erect to spreading shrublet. *Leaves* erect to spreading, straight or curved. *Calyx* glabrous to sparsely puberulous; lobes ovate, elliptic-oblong to broadly oblong, apex acute to cuspidate with a distinct keeltip and median ridge. *Corolla* up to 2×1.2 mm; tube glabrous to puberulous in the lower half rarely up to $\frac{3}{4}$ of the length. *Ovary* glabrous to puberulous on the top. Fig. 22.1-22.6.

CAPE.—3219 (Wuppertal): Middelberg Hut (—AC), Barnes in Bol 19485 (BOL); Sneekup 1070 m (—AC), Bodkin sub Bolus 8628 (BOL; PRE); Middelberg Plateau (—AC), Bond 1359 (NBG); Juriesberg (—AC), Compton 6269 (NBG); 7023 (NBG; STE); Sneekup 1680 m (—AC), Compton 6270 & 6271 (NBG); Cedarberg Tafelberg (—AC), Esterhuysen 8158 (BOL); Langberg 1520-1820 m (—AC), Esterhuysen 7315 (BOL; K; PRE); Hoogvertoon near Sneeuwig hut, 1280 m (—AC), Haynes 815 (STE); Middelberg (—AC), Levyns 2906 (CT); Lewis in BOL 22217 (BOL); Sneeuwig (—AC/CA), Pocock 393 (BOL; STE);

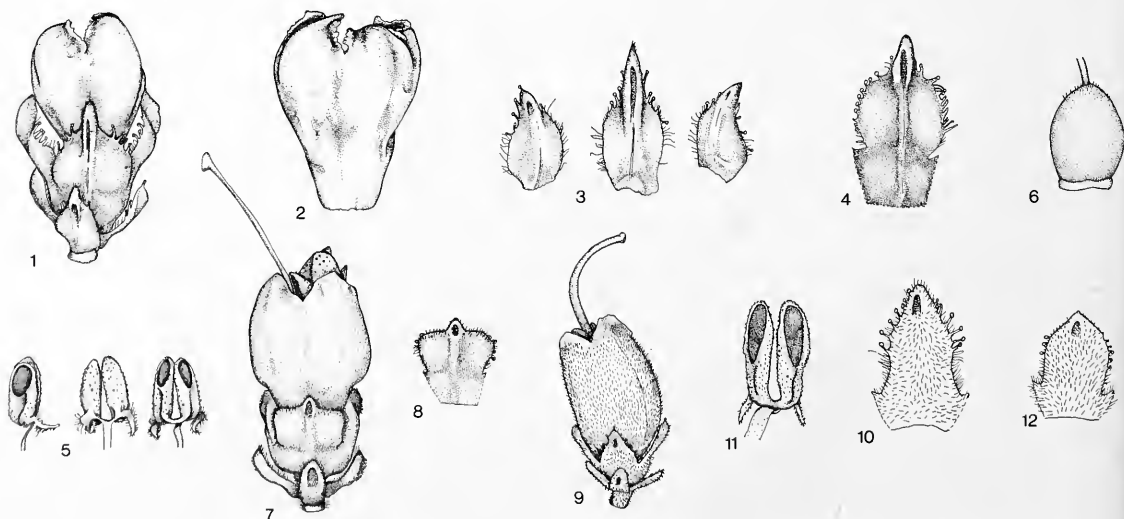
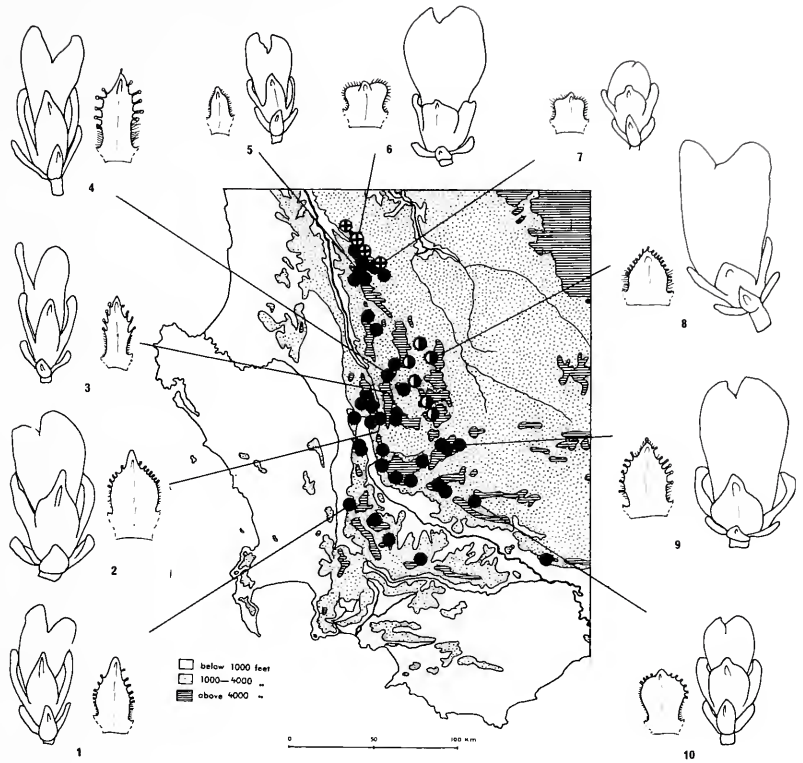


FIG. 22.—*Grisebachia parviflora*: subsp. *parviflora*. 1, flower, $\times 16$; 2, corolla, $\times 16$; 3, bracteoles, $\times 16$; 4, sepal, $\times 16$; 5, anther, side, back and front views, $\times 16$; all drawn from an isolecotype, Zeyher 1117 (STE): subsp. *pubescens*. 7, flower, $\times 16$; 8, sepal $\times 16$; both drawn from Esterhuysen 5924 (PRE): subsp. *eglandula*. 9, flower, $\times 8$; 10, sepal, $\times 16$; 11, anther, $\times 16$; all drawn from the holotype, Oliver 4310 (STE); 12, sepal, $\times 16$, drawn from Oliver 4312 (STE).

FIG. 23.—Distribution of *Grisebachia parviflora*. ● subsp. *parviflora*; ⊕ subsp. *eglandula*; ○ subsp. *pubescens*; Variation in floral and sepal characters for a selection of specimens is shown. 1, *Stokoe* 6567; 2, *Zeyher* 1117; 3, *Lewis* sub BOL 22009; 4, *Compton* 6625; 5, *Haynes* 815; 6, *Esterhuysen* 5924; 7, *Schlechter* 8818; 8, *Oliver* 4310; 9, *Middlemost* 2246; 10, *Oliver* 311. All $\times 10$.



Koupoort near Krakadouw (-AC), *Pocock* 546 (STE); Tafelberg 1830 m (-AC), *Stokoe* in SAM 55134 (NBG; PRE); Sneeuksop (-AC), *Stokoe* in SAM 55154 (SAM); Elandskloof (-CA), *Esterhuysen* 3227 (BOL; K; NBG; PRE); Donkershoek Kop, 1520 m (-CA), *Stokoe* 9246 (BOL); Duiwelskloof (-CA), *Stokoe* in SAM 65522 (SAM; STE); Middeltuyn, Cold Bokkeveld (-CC), *Hanekom* 792 (K; PRE); Bokkeveld Tafelberg, 1890 m (-CD), *Schlechter* 10091 (BM; BOL; E; G; K; MO; P; PRE; S; STE; W; Z); 1370 m (-CD), *Bond* 702 (NBG); De Keur (-CD), *Compton* 6625 (NBG); *Compton* 16126 (NBG; STE). Without precise locality: Cedarberg, *Primos* sub *Marloth* 11678 (PRE); *Primos* sub *Marloth* 11729 (PRE); Koude Bokkeveld, 1520 m, *Schlechter* 8896 (BM; BOL; E; G; K; MO; NH; P; PRE; S; STE; W); 3319 (Worcester): Winterhoek Ridge Peak, 1650 m (-AA), *Andreae* 1113 (PRE; STE); 7 miles West of Gydo Pass (-AA), *Hutchinson* 1030 (BOL; K); Peak below Great Winterhoek 1830 m (-AA), *Phillips* 1817 (BOL; SAM); Great Winterhoek, 1830 m (-AA), *Phillips* s.n. (BOL; K); Visgat (-AA), *Pillans* 9684 (BOL; PRE); Visgat (-AA), *Stokoe* in SAM 63952 (BM; SAM; STE); Sneeuugat (-AA), *Stokoe* 7266 (BOL); Little Winterhoek 2018 m (-AA), *Stokoe* 6065 (K; NBG); Hartebeest Kloof, Bokberg 1188 m (-AB), *Kirsten* 442 (STE); Op-die-Berg Village, 980 m (-AB), *Oliver* 4032 (B; E; MO; PRE; STE; S); Hartebeest Kloof, Valboskloofberg, 1140 m (-AB), *Oliver* 5147 (STE); top of Gydo Pass (-AB), *Lewis* in BOL 22009 (BOL; P); top of Gydo (-AB), *Maguire* 1778 (NBG; PRE; STE); Inkrui, Witsenberg (-AC), *Esterhuysen* 23450 (BOL, K, PRE, STE); Tulbagh Waterfall, 420 m, (-AC), *Bolus* 5304 (BOL; K; PRE; SAM); MacOwan 2685 (SAM); 270 m (-AC), *MacOwan* in Herb. Norm 564 (BM; BOL; G; K; P; PRE; SAM; UPS; W); Witsenberg near Steendahl, 400 m (-AC), *Bolus* 5376 (BOL); Roodesandberg (-AC), *Compton* 6624 (NBG); Witsenberg near Tulbagh (-AC), *Leighton* 1333, (BOL; PRE); Flats between Witsenberg and Schurftberg (-AC/AD), *Zeyher* 1117 (BOL; G; K; SAM; STE; W); Slab Peak, 1220 m (-AD), *Compton* 11960 (NBG); Slab Peak, Michells Pass (-AD), *Esterhuysen* 6182 (BOL); *Stokoe* in SAM 54996 (SAM); Mostertshoek 1220-1520 m (-AD), *Esterhuysen* 9882 (BOL); 300 m (-AD), *Guthrie* 2414 (BOL); Gorge west of Ceres (-AD), *Hutchinson* 610 (BM; B/L; K; PRE); Ceres, lower slopes, 610 m (-AD), *Levyns* 4702 (CT); Matroosberg (-BC), *A. Bolus* s.n. (BOL); *Lamb* 610 (BOL); 1520 m, *Marloth* 2215 (BOL; PRE); *Marloth* 2351b (PRE); Matroosberg near Lakenvlei 1220 m (BC), *Phillips* 1983, (SAM); 1980 m (-BC), *Phillips* 2134 (SAM); Prospect Peak, Hex River Valley, 760 m (-BC), *Esterhuysen* 15908

(BOL; PRE); Bokkerivier (-BD), *Middlemost* 2246 (NBG); *Middlemost* 2278 (NBG); Du Toit's Peak 1220 m (-CA/CC), *Esterhuysen* 23775 (BOL); Molenaarsberg 914 m (-CA), *Esterhuysen* 30354 (BOL; S; STE); Seven Sisters Wellington (-CA), *Stokoe* 6067, (K; NBG; PRE; STE); Audensberg, 1670 m (-CB), *Compton* 9761 (NBG; STE); Brandwacht Peak 1828 m (-CB), *Esterhuysen* 11004 (BOL; PRE); Stettynsberg, 1670 m (-CD), *Esterhuysen* 11057 (BOL); Keeromsberg, 1270 m (-DA), *Esterhuysen* 9293 (BOL); Wild (Wilge) River (-DA), *Niven* s.n. (BM); Saw Edge Peak 3000 (DA), *Oliver* 3793 (K; MO; PRE; STE); Koo Mountain above Berger's Pass, (-DB), *Oliver* 311 (STE); Wildepaardeberg (-DC), *Stokoe* 2527 (BOL; K); 3320 (Montagu); Leeurivierberg (-CD), *Esterhuysen* 27874 (BOL; PRE; STE); Without locality: *Wordsworth* 14034 (K); *Niven* s.n. (G-DC).

G. parviflora is characterized by the flowers being 1-4-nate in small heads clustered along the branches in a congested spike-like manner, the corolla tube not contracted in the middle and the simple cilia on the calyx lobes. The species is closely allied to *G. minutiflora* and has a remarkable superficial resemblance to *Eremia curvistyla* (N.E. Br.) E. G. H. Oliver differing basically in the number of stamens. All three species are sympatric.

The true identity of this species has been overlooked until now as it has nearly always been referred to the later *G. eremioides* MacOwan. Klotzsch in describing it placed the species in Don's genus *Eremia* using as his type an Ecklon & Zeyher collection from "Hills between Puspas Valley and Kogmans-kloof Mountains". Without seeing the type, N. E. Brown followed Klotzsch in keeping the species in *Eremia*. But later in his work on *Grisebachia* he stated that he had seen the type and found that the species was conspecific with *G. eremioides* which he proceeded to retain under the Kew Rule. This was picked up by Druce in his search through Flora Capensis for new combinations but never applied by subsequent botanists.

Unfortunately the holotype in Berlin is no longer extant and all the Ecklon & Zeyher material distributed as *Eremia parviflora* Klotzsch turns out to be *Anomalanthus scoparius* Klotzsch. N. E. Brown on examining the type sent to him on loan stated "The description of Klotzsch is very erroneous, as the calyx is not subequal to the corolla, but considerably shorter than it, and the stamens are 4, not 8 as Klotzsch states. It is identical with Zeyher 1117, except that the leaves are straighter, like those of Schlechter 10091". This statement clears up the discrepancies in the type description and also paves the way for the typification of the species. Without any authentic duplicate material available, I consider that it is justifiable to rely on N. E. Brown's comparison and therefore select Zeyher 1117 in the herbarium at Kew as the neotype. The above published note by N. E. Brown also appears on the sheet at Kew.

Five duplicates of Zeyher 1117 are located in various herbaria and all come from "Flats between the Witsenberg and Skurfsberg". The locality of Houw Hoek on one of the sheets in SAM as cited by MacOwan in his protologue is erroneous.

To date no additional material of *G. parviflora* has been collected in the same area as that visited by Ecklon & Zeyher. But in the variation pattern, I have found in the calyx that the broadly elliptic-acuminate lobes of Zeyher 1117 could well have occurred in the holotype. The leaf difference noted by N. E. Brown is not vitally significant as variation in this character has been noted even on the same plant.

The basic variation occurring in *G. parviflora* is found in the shape of the calyx lobes, the arrangement of the leaves and the indumentum of the flowers, the widest range being in the shape of the calyx lobes. In subsp. *parviflora* three groups occur:

- (a) large lobes with a broad elliptic base and acuminate apex, sparsely gland-ciliate or ciliate, common, central to southern in distribution represented by the neotype, Zeyher 1117;
- (b) large lobes, narrow elliptic-oblong with an acute apex, distinctly gland-ciliate, less common and confined to the central region of the distributional range (Winterhoek to central Cold Bokkeveld);
- (c) small lobes mostly elliptic-oblong with an acute apex, northern in distribution centred on the southern and central Cedarberg.

N. E. Brown described (b) and (c) with their narrow elliptic-oblong acute lobes in combination with the possession of erect straight leaves as a separate variety, var. *grata*. I have found that neither the calyx lobe shape nor the leaf arrangement show any significant differences. There is a definite intergrading between the broad based apiculate and the narrow elliptic-oblong acute sepals as seen in Compton 6624 from Roodesandberg, Stokoe 6067 from the Wellington mountains and Esterhuysen 11057 from Stettynsberg. In leaf arrangement variation from erect straight leaves through to curved slightly spreading leaves can occur on the same plant. There were therefore no grounds for keeping the two species separate.

N. E. Brown also described *G. similis* var. *publicalyx*. The collection Maguire 1778 from Gydo, presumably from one population, possesses glabrous calyces. This also occurs in the Compton and Esterhuysen collections from Slab Peak. The indumentum of both

the calyx and corolla occurs randomly with most southern collections having a glabrous calyx but the lack of hairs and pubescence of the collections from the northern Cedarberg and eastern Bokkeveld are significant in the delimitation of subsp. *eglandula* and subsp. *pubescens*.

(b) subsp. *eglandula* (N.E. Br.) E. G. H. Oliver, stat. nov.

Grisebachia eremoides var. *eglandula* N.E. Br. in Fl. Cap. 4, 1: 349 (1906). Syntypes: Cedarberg Range at Ezels Kop, Schlechter 8818 (BM!; BOL!; G!; K!; P!; PRE!; STE!; Z!); near Clanwilliam, Leipoldt 135 (BOL!). Lectotype: Leipoldt 135 (BOL).

Small shrublet, compact to spreading. Leaves stiffly trigonous, markedly spreading-recurved when mature. Calyx lobes subquadrate, subtruncate with a thickened apiculus, rarely very broadly angular-ovate, closely ciliate with short simple hairs occasionally with a few sessile glands, otherwise glabrous, rarely sparsely puberulous. Corolla glabrous, rarely sparsely puberulous. Ovary thickly pubescent on the upper half. Fig. 22.7, 22.8.

CAPE.—3219 (Wuppertal); Pakhuis (—AA), Barker 4505 (NBG); Esterhuysen 5924 (BOL; PRE); Esterhuysen 21764 (BOL); Krakadouw, 910 m (—AA), Bodkin s.n. (BOL); Stokoe in SAM 55129 (NBG; PRE; SAM); Stokoe in SAM 56776 (SAM); Rocklands, 790 m (—AA), Kruger 1031 (STE); Eselbank, 1220 m (—AC), Schlechter 8818 (BM; BOL; G; K; P; PRE; STE; Z); Crevasse Peak, 1220 m (—AC), Taylor 7459 (PRE; STE). Without precise locality: near Clanwilliam, Leipoldt 135 (BOL); Bokkeveld, 1580 m, Schlechter 8919 (7) (BM; BOL; E; G; K; MO; P; PRE; STE; UPS; W; Z).

In the Cedarberg, the northern part of the distribution range of this species, two reasonably distinct groupings, A & B, of specimens can be made on the shape of the calyx lobes, the pubescence, the arrangement of the leaves and the distribution. Group A has small narrow acute puberulous calyx lobes with no marked apiculus and erect straight leaves and is ascribed to subsp. *parviflora*. Group B has generally small flattened quadrate to subquadrate glabrous calyx lobes with a distinct apiculus and markedly recurved leaves. The pubescence on the ovary is much longer and denser.

There is very little overlap in these characters between the two groups in the Cedarberg and both seem to be fairly distinct. The affinities of group B appear to lie with the collections much further south. The leaf arrangements in A and B are very distinct in the Cedarberg but not between B and some random southern collections of subsp. *parviflora* in which the leaves can be spreading and curved eg. in Bolus 5403 from Tulbagh. The calyx shapes of B, although distinct in the Cedarberg, have similarities in some southern collections.

The distributions of the two groups A & B are relatively easily separable with A occurring west and south of the Krakadouw-Welbedacht mountain range and B north and east of the range. A detailed investigation of the range is necessary to ascertain whether this separation is in fact true or just due to lack of records.

There is, then, in the Cedarberg a reasonable discontinuity in several characters coupled with a spatial separation. This should warrant recognition at specific level, but as there are definite similarities with certain elements to the south, I feel that recognition is only justifiable at subspecific level.

On two collections N. E. Brown described this vicariad as var. *eglandula*. An examination of all the collections showed that small sessile glands are present on the margins of the calyx.

N. E. Brown annotated the collection *Leipoldt* 135 in BOL as the type. It is unfortunate that it is unlocalized.

The collection *Schlechter* 8919 given as just Bokkeveld is undoubtedly this subspecies and I regard the locality as an error.

(c) subsp. *pubescens* E. G. H. Oliver, subsp. nov., a subspecies typica et subspecies *eglandula* floribus majoribus, tubo corollae omnino pubescenti, calyce omnino pubescenti, distributione et florescentia dignoscenda.

TYPE.—Cape, Ceres Dist: Katbakkies in the Swartruggens (—DC) *Oliver* 4310 (STE, holo.; BM; BOL; E; G; K; MO; NBG; PRE; S).

An erect to spreading shrub up to 50 cm high. *Calyx* pubescent; lobes oblong-triangular to broadly so, ciliate with fine simple hairs and stouter gland-tipped hairs admixed. *Corolla* 2–3 mm long and 1,2–1,7 mm broad; tube pubescent over the whole length, tubular-ellipsoid. Fig. 22.9–22.12.

CAPE.—3219 (Wuppertal): Schurweberg, east of Bokkeveld Tafelberg, 1060 m (—CD), *Esterhuysen* 20651 (BOL; K; NBG; MO; PRE; S; STE); Zuurvlakte north of Rietveld in the Swartruggens, 1060 m (—CD), *Oliver* 6114 (PRE; STE); Katbakkies in the Swartruggens, 1220 m (—DC), *Levyns* 1860 (CT; SAM); 1188 m, *Oliver* 4310 (BM; BOL; E; G; K; MO; NBG; PRE; S; STE); *Oliver* 4312 (B; C; G; GRA; HAM; MEL; P; STE; W; Z); 1066 m, *Taylor* 5890 (PRE; STE). 3319 (Worcester): Winkelhaak, 960 m (—AB), *Oliver* 4318 (BOL; E; K; MO; NBG; PRE; STE); Onverwacht in S. Swartruggens, 1220 m (—BA) *Acocks* 23660 (PRE; STE); Baviaansberg, 1060–1220 m (—BA), *Esterhuysen* 29847 (BOL).

There are several collections from the eastern part of the Cold Bokkeveld which have a different appearance and earlier flowering time from the rest of the collections of *G. parviflora*. The flowers are generally much larger with the corolla tube completely pubescent. The Levyns collection from Katbakkies has the corolla tube pubescent for three-quarters of its length. In nearly all the collections of *G. parviflora* the corollas are glabrous to puberulous and then usually below the level of the sepals. The collections of Middlemost from Bokkerivier to the south are intermediate tending towards the pubescence of the Levyns collection.

The flowering time of the eastern Bokkeveld collections is significant being from June to September for material in full flower. The collections of *Levyns* 1860 and *Esterhuysen* 20651 & 29847 and *Oliver* 6114 though recorded for Sept., Oct. and Nov. are of fruiting material. The flowering time for collections of *G. parviflora* elsewhere and particularly in the adjoining areas of the Bokkeveld are Sept.–Dec. for material in full flower. This means that cross-pollination, even if the populations were sympatric, could not take place. The Middlemost collections from Bokkerivier were collected in November in full flower.

Despite there being little morphological disjunction between the group of eastern Bokkeveld collections and the rest of *G. parviflora*, I consider that the geographical and reproductive isolation warrants recognition of this group as a distinct subspecies of *parviflora*.

7. *Grisebachia minutiflora* N.E. Br. in Fl. Cap. 4, 1: 348 (1906). Type: Cape, near Klein Vlei in Cold Bokkeveld, *Schlechter* 10064 (BM!; BOL!; G!; K, holo!; MO!; P!; PRE!; S!; STE!; W!).

Low compact to semi-spreading shrublet up to 20 cm high. Branches long when spreading and sometimes rooting at the nodes, pubescent, with glandular hairs intermingled when young, 3-angled when young. *Leaves* 3-nate, up to 3,5 mm long, the petiole 0,5 mm long, ovate to narrowly oblong, straight erect or slightly spreading, imbricate or shorter than the internodes, subobtusate, thick, pubescent or glabrous when young with a few to numerous sessile glands on the margins, becoming glabrous except on the adaxial surface, sometimes terminating in a sessile gland. *Flowers* in terminal globose heads of up to 36 flowers on short branchlets, not forming congested spikes, white; pedicels almost none up to 0,8 mm long; bracteoles 3, adpressed or recurved-spreading, equal or very unequal in some outer flowers in inflorescences, mostly 0,5–1,7 mm long, if equal then linear acute or subacute and minutely keel-tipped, if unequal then the median one large and leaflike and well keeled, glabrous or pubescent, ciliate towards the base with simple hairs and a mixture of simple and larger plumose and gland-tipped hairs towards the apex. *Calyx* 4-lobed from $\frac{1}{2}$ – $\frac{2}{3}$ its length, up to 1,9 mm long, pubescent, the pubescence short over the whole surface or in zones with sometimes longish hairs; tube obconic or tubular with spreading lobes; lobes ovate-oblong to very broadly ovate up to 0,9 mm long and 1 mm broad, erect or spreading, sometimes with pubescence on the inside at the top, ciliate with short or long cilia which are simple or variously plumose from base to apex, mostly gland-tipped, keel-tipped and thickened, acute to subobtusate. *Corolla* 4-lobed, obconic to tubular with spreading upper half, not constricted, glabrous inside and outside, up to 2,4 mm long; lobes short broad obtuse slightly crenulate, erect or slightly spreading. *Stamens* 4, manifest or slightly exerted; filaments filiform, glabrous, sigmoid at the apex; anthers up to 0,7 mm long with almost parallel sides, oblong, minutely scabrous, awned about $\frac{1}{2}$ the way up the back of the cell; awns up to $\frac{1}{2}$ the length of the cell sometimes spreading; pore about $\frac{1}{2}$ the length of the cell. *Ovary* 2-celled with a single pendulous ovule per cell, ellipsoid, puberulous at the apex; style filiform, glabrous, far exerted up to 2,2 mm long; stigma simple or slightly swollen. Fig. 24.

A species forming compact erect to semispreading low shrublets, occurring in sandy places in the Cold Bokkeveld north of Ceres, flowering from October to January.

A variable taxon in which two subspecies are recognized.

Key to the subspecies

Cilia on the calyx gland-tipped.....(a) subsp. *minutiflora*
Cilia on the calyx not gland-tipped.....(b) subsp. *nodiflora*

(a) subsp. *minutiflora*

G. minutiflora N.E. Br. in Fl. Cap. 4, 1: 348 (1906). Type: *Schlechter* 10064 (K, holo!; numerous isos!).

Leaves pubescent when young with several sessile glands on the margins, becoming glabrous except on the adaxial surface, or glabrous with numerous sessile glands over the surface but pubescent on the adaxial surface. *Pedicels* almost absent or up to 0,4 mm long; bracteoles usually adpressed, mostly up to 1,1 mm long, occasionally up to 1,3 mm. *Calyx* pubescent in zones, glabrous on inner surface, cilia plumose or simple, gland-tipped. Figs 24.1–24.8 & 25.

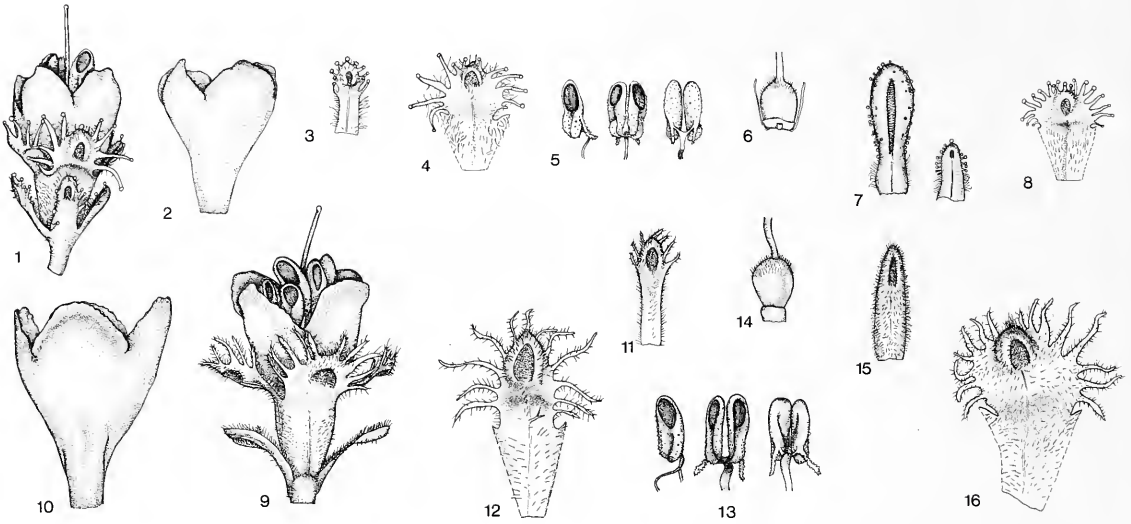


FIG. 24.—*Grisebachia minutiflora*: subsp. *minutiflora*. 1, flower; 2, corolla; 3, median bracteole; 4, sepal; 5, anther, side, front and back views; 6, ovary; all drawn from an isotype, *Schlechter* 10064 (STE); 7, variation in median bracteole, drawn from *Oliver* 4105 (STE); 8, sepal, drawn from *Oliver* 6106 (STE); subsp. *nodiflora*, form A. 9, flower; 10, corolla; 11, median bracteole; 12, sepal; 13, anther, side, front and back views; 14, ovary; all drawn from an isotype, *Schlechter* 10188 (STE); form B. 15, median bracteole; 16, sepal; both drawn from *Schlechter* 10188 (STE). All drawings $\times 16$.

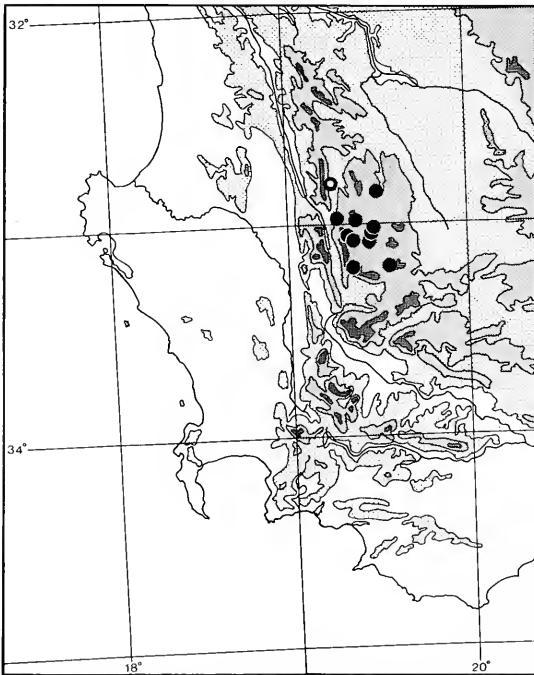


FIG. 25.—Distribution of *Grisebachia minutiflora*. ● subsp. *minutiflora*; ○ subsp. *nodiflora*.

CAPE.—3219 (Wuppertal), between de Keur and Kromfontein, 914 m (—CD), *Oliver* 4105 (BM; C; E; G; K; MO; MEL; P; PRE; S; STE; W; Z); Rietvlei Dam in Swartkops, 970 m (—CD), *Oliver* 6106 (PRE; STE); Stompiesfontein in the Swartkops (—DC), *Esterhuysen* 29304 (BOL; STE). 3319 (Worcester), near Sandberg (—AB), *Bond* 659 (NBG); *Esterhuysen* 3457 (BOL; PRE); Gydo, 1370 m (—AB), *Compton* 18722 (NBG); Gydoberg (—AB), *Leighton* 2254 (BOL; PRE); between Loch Lynne and Winkelhaak, 960 m (—AB), *Oliver* 5117 (B; BOL; E; G; K; MO; PRE; STE); S.W. of Winkelhaak,

960 m (—AB), *Oliver* 5124 (C; GRA; K; P; PRE; STE); Tuinsklouf, south of Houdenberg, 940 m (—AB), *Oliver* 5130 (BOL; MEL; NBG; PRE; STE); near Klein Vlei, 1220 m (—AB), *Schlechter* 10064 (BM; BOL; G; K; MO; P; PRE; S; STE; W); Baviaansberg, 1676 m (—BA), *Bond* 1436 (NBG); 1463 m, *Stokoe* 4543 (BOL); *Stokoe* 4550 (BOL; K).

(b) subsp. *nodiflora* (N.E. Br.) E. G. H. Oliver, stat. nov.

G. nodiflora N.E. Br. in Fl. Cap. 4, 1: 438 (1906). Type: Cape, Schoongezicht in Cold Bokkeveld, *Schlechter* 10188 (BM; BOL, lecto!; E!; G!; K!; MO!; P!; PRE!; S!; STE!; W!; Z!).

Leaves pubescent when young, occasionally with a few sessile glands on the margins. *Pedicels* up to 0,8 mm long; bracteoles usually adpressed and recurved towards the apex, mostly up to 1,7 mm long. *Calyx* pubescent in zones or evenly with pubescence also on the inner surface in the upper quarter, cilia plumose to the apex and not gland-tipped. Fig. 24.9–24.16.

CAPE.—3219 (Wuppertal), Schoongezicht, 1370 m (—CC), *Schlechter* 10188 (BOL & numerous duplicates).

G. minutiflora is characterized by the globose inflorescences of 6–36 flowers scattered along the branches, the corolla-tube not contracted in the middle, the plumose cilia on the calyx lobes and the general glandular condition of the flowering branches. It is closely allied to *G. parviflora*.

When Brown revised the genus he had two collections of *Schlechter* to examine and justifiably described them as two new species, *G. minutiflora* and *G. nodiflora*, basing them on the presence or absence of gland-tipped plumose or simple cilia on the calyx lobes.

Since then no further material referable to *G. nodiflora* has been collected, but there have been 12 collections of *G. minutiflora*. The type of *G. nodiflora* possesses no glands on the calyx lobes, whereas in the collections of *G. minutiflora* there are always some glands present on the cilia, but these may be extremely small in some flowers. The material

was then examined for other characters. Brown used the differences in the size of the inflorescence heads, but this is invalid as the heads in *Oliver* 4105 are much larger than in *Schlechter* 10188. He also used the degree of feathering on the cilia, but this is very variable in *G. minutiflora* from simple to almost fully plumose.

Slight differences were found in the length of the pedicel which is absent to 0.4 mm long in *G. minutiflora* and up to 0.8 mm long in *G. nodiflora*. The bracteoles of the former are usually adpressed whereas in the latter they are approximate but curved-spreading. I decided to reduce *G. nodiflora* to sub-specific level under *G. minutiflora*, because of the difference in the glandular state of the cilia and the slight discontinuities in the bracteoles and pedicel characters coupled with the allopatric distribution.

At first examination I found that there was a distinct difference in the type of pubescence on the calyces with *G. minutiflora* having zones that were pubescent and glabrous and with *G. nodiflora* having an evenly pubescent calyx. Close examination of *Schlechter* 10188 duplicates showed there to be two distinct forms. In one the pubescence is zoned as in *G. minutiflora*, in the other it is evenly distributed over the calyx, a condition not found in *G. minutiflora*. This variability suggests a closer relationship between the two taxa than was previously accorded to them.

The material on sheets of *Schlechter* 10188 can easily be separated into two forms, A & B, on the type of pubescence and the shape of the calyx lobes. In form A the pubescence is zoned and the calyx lobes are oblong to elliptic-oblong acute. In form B the pubescence is denser and evenly distributed over the calyx the lobes of which are transversely broadly elliptic obtuse. These variations can only be recognised as forms at present as they presumably came from one population. This has not been rediscovered and until such time as it is, no further status can be given to this variation.

The specimens examined in detail have been assigned to the two forms as follows:

Herbarium	Form A	Form B
BOL.....	1 twig	—
BOL.....	2 twigs	—
E.....	—	4 twigs
MO.....	1 twig	2 twigs
PRE.....	2 twigs	1 twig
STE.....	1 twig	1 twig
K.....	1 twig	1 twig

N. E. Brown did not designate a holotype but labelled one sheet in BOL (form A only) and one in K (form A & B) as types. From the protologue two characters can be pinpointed to determine which form he used to describe his species, i.e. "calyx lobes oblong, acute". These undoubtedly refer to form A. I have therefore chosen the *Schlechter* sheet labelled as the type in BOL as the lectotype.

8. *Grisebachia secundiflora* E. G. H. Oliver sp. nov., in genere singulari ovario unicellulari et inflorescentiis secundis densis sed affinis *G. parviflorae* (Klotzsch) Druce.

Frutex humilis compactus vel effusus ad 0.8 m altus. Rami multi ascendentes foliis tantum ad extrema, pubescentes demum canopubescentes et lamelliformes. Folia 3-nata imbricata demum patentia 3-4 mm longa petiolo 1 mm, anguste ovata ad elliptica, pubescentia glabrescentia, ciliata ciliis brevibus crassis plumosis et apiculata demum

serrulata, interdum ciliis glandulis parum glauca ad olivacea; petiolo quam lamina pubescentiora. Flores 3-nati in remulis axillaribus brevissimis, aggregate in pseudospicam secundam dense farotam ad 3.5 cm longam versus extrema ramorum; pedicellis brevissimis 0.5 mm longis; bracteolis 3 adpressis, mediana ad 1.0×0.6 mm saepe minore quam lateralibus ovatotriangulare, lateralibus ad 1.3×0.6 mm anguste ovatis, interdum obliquis, omnibus glabris ad pubescentibus, ciliatis ciliis simplicibus vel plumosis interdum glandulis, apiculatis cilio longo plumoso, albidis ad chlorinis. Calyx 4-lobatus campanulatus ad 2.1 mm longus junctus quadrante ad tertia parte, ad dimidio tubi corollae glaber ad puberulus albidus ad chlorinus; lobis in latitudine inaequalis, ab- et adaxialibus latioribus quam lateralibus, late ovatis ad obovatis parum cucullatis ciliatis ciliis plumosis crassis interdum glandulis cum ciliis simplicibus immixtis, apiculatis, indistincte sulcatis apice. Corolla 4-lobata 3.5-4.5 mm longa et 1.3-1.6 mm lata, angusto tubulosa et parum inflata in parte tertio e basi, ad breviora multo inflata in dimidio interiore, pubescens in parte medio et intra glabra, albidus; lobis 0.6×0.6-1.0×0.9 mm erectis ad parum patentibus, obtusis, glabris. Stamina 4 libera; filamentis anguste linearibus glabris albidis; antheris ad 1.0×0.5 mm, inclusis ad manifestis, subbasaliter dorsifixis, laevigatis ad minute scabridis, aristatis; aristis dorsalibus, deorsum currentibus, cellulis plus minusve dimidio brevioris; pollinis singularibus. Ovarium 1-cellulare ovulo uno pendulo apicale, rarissime 2-cellulare, parum obliquum, 0.7-0.6 mm glabrum viride; disco distincto rubro; stylo filiformi 4.0-4.5 mm longo, exserto glabro; stigmatibus capitellato.

TYPE.—Cape, Ceres District, Swartruggens in the Cold Bokkeveld, *Oliver* 6105 (STE, holo.; BM; BOL; E; G; K; MO; NBG; P; PRE: S; W).

Low compact but sprawling shrublets up to 0.5 mm high, much branched. Branches numerous ascending with leaves only towards the ends, finely pubescent becoming grey pubescent and flaky with age. Leaves 3-nate, closely imbricate, spreading when older mostly 3-4 mm long with the petiole 1 mm long, narrowly ovate to elliptic, pubescent becoming glabrous, ciliate with short stout plumose hairs and apiculate with a long stout plumose hair, becoming serrulate, occasionally with gland-tipped cilia when young, slightly glaucous to olive-green; the petiole more pubescent than the lamina. Flowers 3-nate on very short axillary branchlets crowded into a densely packed secund pseudo-spike up to 3.5 cm long towards the ends of the main branches; pedicel very short about 0.5 mm long; bracteoles 3 adpressed to the calyx, the median up to 1.0×0.6 mm often smaller than the laterals, ovate-triangular, the laterals up to 1.3×0.6 mm narrowly ovate sometimes oblique, all glabrous to pubescent, ciliate with simple and plumose cilia sometimes gland-tipped, apiculate with a long plumose hair, white to pale yellow-green. Calyx 4-lobed campanulate up to 2.1 mm long joined from quarter to one third of its length, reaching halfway up the corolla-tube, glabrous to puberulous white to pale yellow-green; lobes unequal in width, 1-1.7 mm, the ab- and adaxial being broader than the laterals, broadly ovate to obovate slightly cucullate, ciliate with stout plumose cilia which may be gland-tipped with simple cilia inbetween, apiculate, indistinctly sulcate at the apex. Corolla 4-lobed 3.5-4.5 mm long and 1.3-1.6 mm wide, narrow tubular and slightly inflated one third of the way up

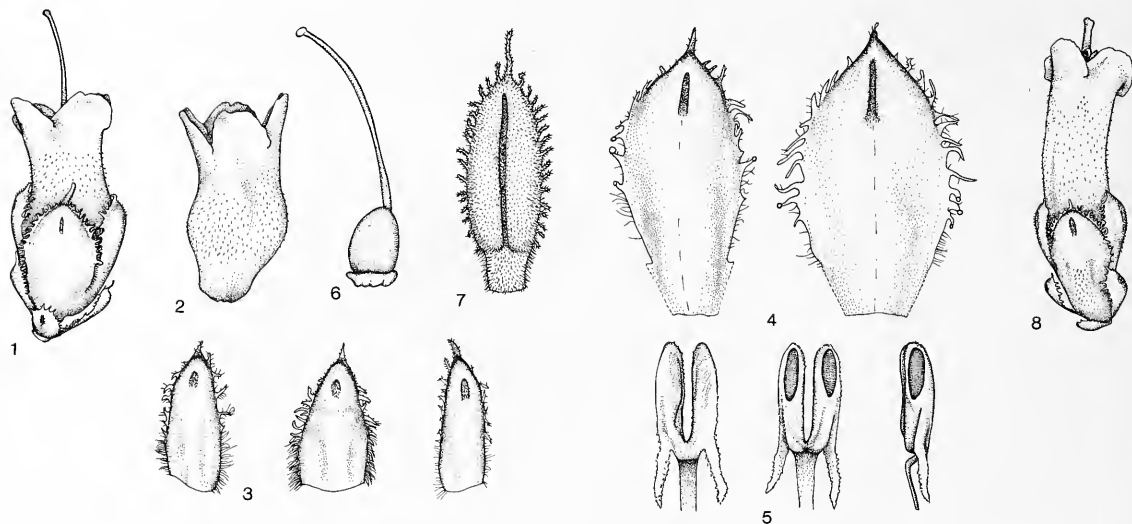


FIG. 26.—*Grisebachia secundiflora*. 1, flower, $\times 8$; 2, corolla, $\times 8$; 3, three bracteoles, $\times 16$; 4, sepals, lateral and abaxial, $\times 16$; 5, anther, back, front and side views, $\times 16$; 6, gynoecium, $\times 16$; 7, leaf, $\times 8$; all drawn from the holotype, Oliver 6105 (STE); 8, flower, $\times 8$, all drawn from Oliver 5044 (STE).

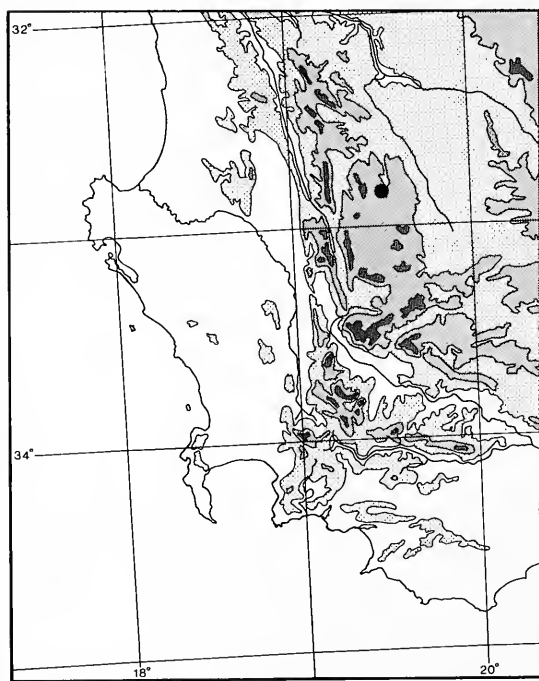


FIG. 27.—Distribution of *Grisebachia secundiflora*.

to short tubular and much inflated in the lower half, finely pubescent in the middle region and glabrous inside, white: lobes varying from 0.6×0.6 – 1.0×0.9 mm, erect to slightly spreading, obtuse, glabrous. Stamens 4, free; filaments narrow linear, glabrous white; anthers up to 1.0×0.5 mm, included to manifest, subbasally attached on the dorsal surface smooth to minutely scabrid, aristate; awns dorsal pointing downwards, about half the length of the cell, minutely ciliate, white; pore about half the length of the cell; pollen grains single. Ovary 1-celled with a single pendulous apical ovule, very rarely

2-celled, slightly oblique, 0.7×0.6 mm, glabrous, greenish, seated on a distinct dark red nectariferous disc; style filiform, 4.0 – 4.5 mm long, exserted, glabrous; stigma capitate. Figs 26 & 27.

CAPE.—3219 (Wuppertal); Rietvlei (—CD), MacGregor in BOL 31286 (BOL); Swartruggens, Rosendal area, north-east of the farmstead, 960 m (—CD), Oliver 6105 (BM; BOL; E; G; K; MO; NBG; P; PRE; S; STE; W); 6107 (B; C; PRE; STE); 1066 m, Oliver 6115 (NBG; PRE; STE). Locality uncertain; Ceres Wildflower Show, Oliver 5044 (PRE; STE). Flowering in October.

G. secundiflora is very distinct in the genus with its erect second pseudospicate inflorescences, its considerably bare branches and 1-celled ovary.

The species was first seen by me at the Ceres Wildflower Show in October 1974 when I was doing the naming of specimens. The collector and locality unfortunately could not be traced. A few weeks later the material collected the previous year in the Swartruggens by Dr J. MacGregor was sent to me for identification.

An examination of the above collections showed that they constituted a new and very distinct species which I was not able to place satisfactorily in any known genus. Following Dr MacGregor's directions, I visited the Swartruggens and located the species in three disjunct sparse populations. A range of material was collected and examined for variations in the critical character, the 1-celled uniovulate ovary. An examination of numerous flowers produced only a few with unequally 2-celled ovaries.

The species is remarkably similar to *Eremia totta* (Thunb.) G. Don in the outward appearance of the flowers and leaves but cannot be placed near that species which has 8 stamens and a 4-celled ovary. *Eremia* has been considerably amended to include the 1-celled *Eremia curvistyla* (N.E. Br.) E. G. H. Oliver but still retains the constant character of eight stamens (Oliver, 1976).

To a lesser extent the species is similar in outward appearances to *Grisebachia parviflora* (Fig. 22) and *G. minutiflora* (Fig. 24) both of which it grew with in the Swartruggens. They all possess four stamens. Until this revision, all species of *Grisebachia* possessed

2-celled ovaries with very few exceptions having 3-celled ovaries.

There were thus four ways of dealing with the new species: (1) placing it under *Eremia* and having to amend the generic circumscription even further to include the 4-stamened condition, thus causing a breakdown in the distinction between *Eremia* and *Grisebachia*; (2) placing it under *Grisebachia* and amending the generic circumscription to include this 1-celled species; (3) placing it in either *Anomalanthus* or *Syndesmanthus*, genera with 4 stamens and a 1-celled ovary, but which have no resemblance to it; (4) describing the species as a separate monotypic genus.

Taking into account the implications of the above, it was decided to broaden the circumscription of *Grisebachia* to include the 3-celled variations particularly in *G. parviflora* subsp. *pubescens* and the 1-celled, rarely 2-celled, condition occurring in the new species.

In the Swartruggens *G. secundiflora* was found in three separate populations consisting of only a few scattered plants each. At the lower altitude the plants were growing on sandy flats with a population of *G. minutiflora* nearby. Higher up the mountain they were growing on sandy, rocky slopes together with some plants of *G. parviflora* subsp. *pubescens*.

In all cases *G. secundiflora* formed decumbent yet compact shrubs up to 0,5 m high and up to 1 m across with numerous ascending to decumbent branches. The branches were strikingly bare and devoid of leaves except towards their ends. The white conspicuous secund inflorescences were subterminal. This contrasted strongly with the very compact low shrublet of *G. minutiflora* or the sparse spreading procumbent to semi-erect plants of *G. parviflora* ssp. *pubescens* which were all in fruit.

Some variation in floral characters occurs. The pubescence on the calyx may be present or absent on different twigs in the collections Oliver 6105, 6107 and 6115 and is present in MacGregor s.n. It is absent in Oliver 5044 from the flower show. The corolla tube in the collections of Oliver and MacGregor from the Swartruggens are short, tubular and inflated in the lower half whereas in the material from the flower show it is distinctly longer and narrower. As this latter material is unlocalized no further comments on its status can be given.

SPECIES NON SATIS COGNITAE

1. *Erica nodiflora* Salisb. in Trans. Linn. Soc. 6: 340 (1802). Type: *Hibbert* s.n. (?).

Blaeria nodiflora G. Don., Syst. Veg. 3: 805 (1834); Klotzsch in Linnaea 12: 246 (1838) sub. sp. non sat. cog.

Bentham places this species under *G. plumosa* Klotzsch and N. E. Brown accepts this. No type specimen has been seen and the description could fit most species of *Grisebachia*.

2. *Erica capitata* Salisb., Prodr. 293 (1796), non L. Type: ?. Bentham and N. E. Brown place this species under *G. plumosa*, presumably because in the Kew copy of the Prodromus Salisbury has written in pencil 'Nodiflora MS'. Salisbury gave no description quoting only Linnaeus incorrectly.

3. *Blaeria ciliaris* sensu Klotzsch in Linnaea 8: 658 (1933), non *G. ciliaris* (L.f.) Klotzsch in Linnaea 12: 225 (1838); N.E. Br. in Fl. Cap. 4, 1: (1906). Type: *Willdenow Herb.* no. 2890 (B1).

Klotzsch wrongly ascribed the Willdenow specimen to the species which had, up until then, been cited as *Blaeria ciliaris* L.f. In his description he stated that the leaves were 4-nate, possibly repeating the slip made by Thunberg and copied by most subsequent authors. The Willdenow specimen has in fact 3-nate leaves.

Rach (1855) in examining Klotzsch's specimen and that of Thunberg stated that they were not of the same species. Brown noted that Thunberg's specimen was identical to the type in the Linnaean Herbarium.

I have been able to examine the Willdenow specimen in the Berlin Herbarium. The material certainly does not belong to *G. ciliaris* (L.f.) Klotzsch subsp. *ciliaris* and is only in young bud stage from which it is not possible to identify it with any certainty.

SPECIES EXCLUDED

Grisebachia eriocephala (Klotzsch) Benth. in DC., Prodr. 7: 702 (1839) based on *Finckea eriocephala* Klotzsch in Linnaea 12: 238 (1838) = *Acrostemon eriocephalus* (Klotzsch) N.E. Br. in Fl. Cap. 4, 1: 335 (1906).

Grisebachia bruniades (Klotzsch) Benth. in D.C., Prodr. 7: 702 (1839) based on *Finckea bruniades* Klotzsch in Linnaea 12: 238 (1838) = *Acrostemon eriocephalus* (Klotzsch) N.E. Br.

UITTREKSEL

Hierdie is 'n hersiening van die genus Grisebachia Klotzsch waarin 8 spesies erkenning geniet. Die genus behoort tot die Ericaceae-Ericoideae en is endemies in die suidwestelike deel van die Kaapprovinsie. Die ondersoek het getoon dat 'n groot mate van variasie onder die spesies voorkom wat dit noodsaak om 7 spesies tot infraspesifieke rang en 7 spesies tot sinonieme te verlaag, terwyl 1 spesie as 'n takson met 'n onduidelike identiteit beskou word. Die nuwe spesies, G. secundiflora E. G. H. Oliver, is beskryf.

REFERENCES

- BENTHAM, G., 1839. Ericaceae. In DC., Prodr. 7: 580-733. Paris.
- BENTHAM, G., 1876. Ericaceae. In Benth. & Hook. f., Gen. Pl. 2: 577-604. London: Reeve.
- BROWN, N. E., 1906. *Grisebachia*. In W.T. Thistleton-Dyer, Fl. Cap. 4, 1: 337-350. Ashford: Reeve.
- BROWN, N. E., 1909. Addenda and Corrigenda, Ericaceae. In W.T. Thistleton-Dyer, Fl. Cap. 4, 1: 1123-1129. Ashford: Reeve.
- DRUDE, O., 1897. Ericaceae-Ericoideae. In Engl. & Prantl, Pflanzenfam. 4, 1: 57-65. Leipzig: Engelmann.
- KLOTZSCH, J. F., 1838. Ericaceum, genera et species. Linnaea 12: 211-247.
- OLIVER, E. G. H., 1975. Ericaceae. In Dyer, Gen. 1: 429-439. Pretoria: Botanical Research Institute.
- OLIVER, E. G. H., 1976. Studies in the Ericoideae. I. The genera *Eremia* and *Eremiella*. Bothalia 12: 29-48.
- PHILLIPS, E. P., 1926. Ericaceae. In Gen. ed. 1, 457-465. Pretoria: Division of Botany and Plant Pathology.
- PHILLIPS, E. P., 1944. Notes on the minor genera of the Ericaceae. JI S. Afr. Bot. 10: 69-73.
- PHILLIPS, E. P., 1951. Ericaceae. In Gen. ed. 2, Pretoria: Division of Botany.
- WEIMARCK, H., 1941. Phytogeographical groups, centres and intervals within the Cape flora. Lunds Univ. Arsskr. 37: 1-143.



A survey of some of the pre-Linnean history of the genus *Acacia*

I. H. ROSS*

ABSTRACT

The pre-Linnean history of the plants referred to the genus *Acacia* to some extent reflects the development of botanical description, classification and illustration. Attention is drawn to some of the earliest references to plants known to belong to the genus *Acacia* and to references in selected herbals and publications up until Philip Miller's description of the genus in the fourth abridged edition of his *Gardeners Dictionary* in 1754.

RÉSUMÉ

REVUE DE QUELQUES ÉLÉMENTS DE L'HISTOIRE PRÉ-LINNÉENNE DU GENRE ACACIA

L'histoire pré-linnéenne des plantes rattachées au genre *Acacia* reflète jusqu'à un certain point le développement de la description, de la classification et de l'illustration en botanique. On attire l'attention sur certaines des références les plus anciennes à des plantes connues comme appartenant au genre *Acacia* ainsi qu'à des références puisées dans un choix d'herbiers et de publications antérieures à la description faite de ce genre par Philip Miller dans la quatrième édition abrégée de son "*Gardeners Dictionary*" en 1754.

INTRODUCTION

Although of no standing in present-day nomenclature, it is nevertheless of considerable interest to trace the pre-Linnean history of the plants now referred to the genus *Acacia* as to some extent it mirrors the development of botanical description, classification and illustration.

From the beginning, plants, particularly those of utilitarian value, attracted the attention of man and the use of plants for medicinal purposes long preceded any description of the plants themselves. Since very early times a variety of herbs was used as healing agents and it had become necessary to study them in detail in order to be able to differentiate the kinds employed for different purposes. In the words of Stearn (1958), "Botany as a science was fashioned out of herb-lore at Athens when Theophrastus (370-285 B.C.) applied to the vegetable kingdom the principles of classification based on logic associated with his teachers Aristotle and Plato."

Attempts were made to classify plants in the earliest works on natural history. Theophrastus in his *Enquiry into Plants* considered the principles of classification suggesting that the vegetable kingdom be classed into trees, shrubs, under-shrubs and herbs and that minor divisions should be based on differences such as those between flowering and flowerless and deciduous and evergreen plants. In addition, he hinted at an ecological classification.

A number of manuscript herbals was written in western Europe during the centuries that elapsed between the end of the classical period and the end of the fifteenth century. Theophrastus, Dioscorides and Pliny either gave no descriptions to the names of the plants or they described them so inadequately that it was probably difficult even then, as it still is now, to identify many of the plants referred to in their works. The writers of the early herbals sought to recognize in the plants of their own country those of classical antiquity named by Theophrastus, Dioscorides and Pliny as it was at first assumed that the plants described by the Greek physicians grew wild throughout Europe. As a consequence, each author identified a different native plant with one

mentioned by Theophrastus or Dioscorides or others thereby creating much confusion so that the reader of one work can in many instances never be sure whether the plant referred to by a certain name is the same as a plant with the same name in the work of another author. A description of a plant during the early sixteenth century is therefore usually accompanied by a critical enquiry as to whether the usage of the name agrees with the use to which it was put by other authors. Many of the early works showed little originality being copies of copies of yet earlier copies. During this copying process errors were introduced and descriptions of quite common plants were borrowed from earlier works and embellished with superstitions so that many departures were made from the original texts.

As many of the herbalists were medical men probably one of the objects which early herbalists had in mind when writing their books was to enable the reader to identify the herbs used in medicine. However, until the sixteenth century was well advanced the illustrations generally provided in herbals were often so stylized and the descriptions so inadequate that it must have been extremely difficult to identify many of the plants solely by reference to these works. Arber (1938) suggested that the knowledge of plants was transmitted by word of mouth and that the herbals were only used as reference works in which to seek information about plants whose identity was already known to the reader.

A significant advance occurred when the authors of herbals and other works based their descriptions on the actual plants that they had before them instead of copying earlier descriptions. The descriptions were not very methodical initially but they slowly became more systematic. The herbals of the late sixteenth century mostly contain descriptions of plants known to the author from the immediate environment of his native land. Later authors endeavoured to present a more comprehensive account in each herbal by recording all plants noted by predecessors whether or not they had seen them and adding the previously unknown plants that they had seen themselves. In contrast with previous centuries, the merit of each new herbal came to depend upon the number of plants added from the authors' own observations and not on what the author had copied from predecessors. As each author wished to include in his work as many

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new plants as possible, the number of plants described grew fairly rapidly. Fuchs (1542) described about five hundred species but by 1623 the number of species enumerated by Caspar Bauhin in his *Pinax theatri botanici* had risen to six thousand.

As a product of the process of compiling descriptions the similarities and differences between plants became more apparent to authors along with the realization that some of the affinities had little to do with the medicinal properties or agricultural importance of the plants. A significant advance occurred when information relating to medical superstition was omitted from the descriptions and the perception of natural affinities among plants awakened a desire to distinguish more precisely whatever was different and to bring together more carefully whatever was similar (Sachs, 1890). This perception of resemblances and differences of form developed and led in turn to the idea of natural relationships and systems of classification. The recognition of natural groups is found in the later herbals from the late sixteenth century onwards, and the series of works published between 1530 and 1623, from Brunfels to Caspar Bauhin, reflects how the perception of a grouping of affinity grew more and more distinct.

Caspar Bauhin (1623) considered the arrangement of plants in his *Pinax theatri botanici* to be of the greatest importance and his system was far ahead of those of his predecessors. He employed the system which de l'Obel had used in 1576 in his *Plantarum seu stripium historia* but carried it out more thoroughly. Caspar Bauhin consistently used the binary system of nomenclature, which Linnaeus is often thought to have founded, each plant bearing a generic and a specific name, although sometimes a third or even a fourth descriptive word was added. However, these additional words are apparently only auxiliary and not essential. In his *Pinax*, Caspar Bauhin also sought to put an end to the nomenclatural confusion which had arisen by listing for each species known to him all of the names that had been applied previously by earlier writers.

The art of botanical illustration and the development of plant descriptions proceeded at different rates and to an extent independently of one another. The first millenium of the history of plant illustration shows no steady advance from primitive work to naturalistic, but rather a gradual decline which was not fully arrested until the early sixteenth century with the appearance of Weiditz's illustrations in Brunfels's *Herbarium vivae eicones* (Blunt, 1955). Remarkable examples of some very early large-scale brush drawings are found in the *Codex Aniciae Julianae* of Dioscorides's work. This work was made at Constantinople about the year 512 A.D. but it appears that some of the illustrations were derived from those made by Crateuas who was personal physician to King Mithridates (120–63 B.C.) (Arber, 1938; Stearn, 1954; Blunt, 1955).

As species of *Acacia* occur in the Nile Valley in Egypt and in the middle east it is not surprising that references to plants now known to belong to this genus can be traced back almost to the earliest recorded history. Reference to the genus is found in texts of the ancient Egyptians, in the Bible, and in the writings of classical antiquity. Of course, as is to be expected, many of the plants referred to by the names *Acanthus*, *Acanthos*, *Akakia*, *Acatia* and *Acacia* were unrelated and many are excluded from the present generic concept of *Acacia*.

Attention is drawn in this paper to some of the earliest references to plants known to belong to the genus *Acacia* and to references in selected herbals and publications leading up to Philip Miller's description of the genus in 1754.

THE ANCIENT EGYPTIANS

Species of *Acacia* have flourished on the banks of the river Nile in Egypt for thousands of years and, according to Rochebrune (1899), the ancient Egyptians were familiar with *A. nilotica* (L.) Willd. ex Del. and *A. seyal* Del. and very probably *A. tortilis* (Forssk.) Hayne and perhaps even *A. senegal* (L.) Willd. The name of *A. nilotica* is found in contemporary texts of the pyramids and, of all of the *Acacia* species, its name occurs most commonly in inscriptions in religious and historical texts and in literary and medical papyri. The most frequently used symbol to depict the species is a pod which represented a figure in hieroglyphics. Rochebrune noted that *A. nilotica* is represented on the tomb of Menephtha of the eighteenth dynasty at Beni-Hassan.

Flückiger & Hanbury (1874) record that the Egyptian fleets brought gum arabic from Arabia as early as the seventeenth century B.C. and that there were representations of the trees, together with heaps of gum, in the treasury of King Rhampsinit (Ramses III) at Medinet Abu. The symbol used to signify gum arabic, which was largely used in painting, is frequently encountered in Egyptian inscriptions.

The ancient Egyptians used the flowers of *Acacia* for crowns and garlands, some of which adorned the mummies of certain kings. *A. nilotica* was sometimes placed among the offerings on the altars of the Gods but there is no evidence of its having been sacred, while *Acacia* wood is reputed to have been used to clamp shut mummy-coffins made of sycamore.

THE BIBLE

There is almost universal agreement that the plant referred to in the Bible by the Hebrew word "shittah" (singular) or "shittim" (plural) is a species of the genus *Acacia*, three or four of which occur in biblical lands (Moldenke & Moldenke, 1952). The Bible (The Authorized Version of King James) contains numerous references to shittim-wood particularly in connection with the ark of the Tabernacle which was ordered to be made of this wood. For example, in Exodus 25: 5, 10, 13, 23 and 28—

"And rams' skins dyed red, and badgers' skins, and *shittim wood*. . . And they shall make an ark of *shittim wood*: two cubits and a half shall be the length thereof, and a cubit and a half the breadth thereof, and a cubit and a half the height thereof. . . And thou shalt make staves of *shittim wood*, and overlay them with gold . . . Thou shalt also make a table of *shittim wood*. . . And thou shalt make the staves of *shittim wood*."

Smith & Fuller (1893) record that the predominant use of the plural form of the word in the Scriptures, that is "shittim" rather than "shittah", is probably because the trees are usually gregarious and seldom occur singly. In the Revised Version of the Bible the terms "acacia tree" and "acacia wood" are used.

According to Moldenke & Moldenke (1952), most authorities are of the opinion that *A. seyal* or *A. tortilis* are the most likely species involved in these references. Both species are seemingly able to flourish in dry areas and *A. tortilis* is the largest and commonest tree on the deserts of Arabia where the Israelites wandered for forty years and is especially conspicuous

on Mount Sinai. Although usually shrubby or twisted and gnarled in desert areas, in favourable localities *A. tortilis* may attain a height of 15 metres. Its wood is very hard, close-grained and durable and thus admirably suited for use in the construction of the ark of the Tabernacle.

Other authors feel that *A. seyal* is more probably the species referred to while *A. nilotica* may also be involved. The almost complete absence of references to the "shittah" tree in the later books of the Bible suggests that the tree was not a native of northern Palestine.

It has also been suggested (Felix, 1971) that *A. albida* Del. may be the species in question as it grows in the Jordan Valley near the mouth of the river Yarmuk. *A. albida* is an erect tree with hard light wood which would have provided timber of suitable lengths for the construction of the ark.

In the books of Numbers, Joel, Joshua and Micah the word "shittim" is used as a place name probably, according to the Authorized Version, because of the abundance of acacias at those places at that time. The "Abel-shittim" of Numbers 33:49 literally means "the meadow (or moist place) of the acacias."

The acacia of the Bible is not *Robinia pseudo-acacia* L., the common black locust of eastern North America. This species was confined to North America in biblical times and was only introduced into Palestine at the end of the seventeenth or the beginning of the eighteenth century.

While there is little doubt that the word "shittim" refers to a species of *Acacia*, there is much controversy about the following verses of Exodus 3: 2-4:

"And the angel of the Lord appeared unto him in a flame of fire out of the midst of a bush: and he looked, and, behold, the bush burned with fire, and the bush was not consumed. And Moses said, I will now turn aside, and see this great sight, why the bush is not burnt. And . . . God called unto him out of the midst of the bush."

One of the possible explanations discussed by Moldenke & Moldenke l.c. is that the "flame of fire" may have been the brilliant crimson-flowered mistletoe, *Loranthus acaciae* Zucc., which grows in profusion on *Acacia* species in Sinai and in biblical lands. The crimson flowers of the mistletoe stand out conspicuously against the green foliage and yellow inflorescences of the host plant and some authorities are of the opinion that the story of Moses and the "burning bush" may be an allegory referring to the flame-like appearance of the mistletoe among the branches of an *Acacia*.

THE WRITINGS OF CLASSICAL ANTIQUITY

Scientific botany owes its origins to curiosity about the medicinal properties of plants. Theophrastus (370-285 B.C.), the distinguished Greek philosopher, who was first a disciple of Plato and afterwards the favourite pupil of Aristotle, applied to the vegetable kingdom the principles of classification based on logic associated with his teachers (Stearn, 1958). This is revealed in his work which has come down to us entitled *The Enquiry into Plants*. *The Enquiry into Plants* is chiefly concerned with the plants of the Mediterranean region around Greece, but it also contains some of the observations made during Alexander the Great's military expedition into Asia in the years 331-323 B.C. It is not known from what source Theophrastus first became acquainted with species of *Acacia* but the following mention is made

in the *Enquiry* of acacias which he would have had an opportunity of seeing in Egypt during his visit to the country at the invitation of Ptolemy:

"Thus in Egypt there are a number of trees which are peculiar to that country, the sycamore the tree called *persea* the *balanos* the acacia and some others." (Theophrastus, *Enquiry* IV, ii, 1; transl. Hort 1: 291, 1916).

Theophrastus continued (IV, ii, 8; transl. Hort 1: 299, 1916):

"The *akantha* (acacia) is so called because the whole tree is spinous (*akanthodes*) except the stem; for it has spines on the branched shoots and leaves. It is of large stature, since lengths of timber for roofing of twelve cubits are cut from it. There are two kinds, the white and the black; the white is weak and easily decays, the black is stronger and less liable to decay; wherefore they use it in shipbuilding for the ribs. The tree is not very erect in growth. The fruit is in a pod, like that of leguminous plants, and the natives use it for tanning hides instead of gall. The flower is very beautiful in appearance, so that they make garlands of it, and it has medicinal properties, wherefore physicians gather it. Gum is also produced from it, which flows both when the tree is wounded and also of its own accord without any incision being made. When the tree is cut down, after the third year it immediately shoots up again; it is a common tree, and there is a great wood of it in the Thebaid . . ."

The plant referred to in the latter part of the quotation is apparently *A. nilotica*.

More than two centuries elapsed after the death of Theophrastus before a reference is again found to a plant that is alleged to be an *Acacia*. This reference is in *Georgics*, the work of Virgil (70-19 B.C.), the celebrated Roman poet. Elfriede Abbe in *The Plants of Virgil's Georgics* 129 (1965) translated *Georgics* 2: 118-119, namely, "quid tibi odorato referam sudantia ligno balsamaque et baccas semper frondentis acanthi", as follows:

"Why should I tell you of the balsam that sweats from the fragrant wood and the berries of the everleafy *Acacia*?"

Elfriede Abbe was of the opinion that the *Acacia* referred to in these lines is *A. nilotica*, and maintained that by "baccas" Virgil meant either the round heads of flowers or the moniliform pods which resemble a string of beads.

However, the above interpretation is at variance with some earlier opinions. Parkinson 1549 (1640) wrote:

"Some have thought that the *Acanthus baccifera* of Virgill, mentioned in the second of his *Georgicks*, in these words *Quid tibi odorato* . . ., should be this tree (*A. nilotica*), as *Servius Grammaticus*, and *Christoferus Landius* both of them commenters upon Virgill say; but without true judgement as *Guilandinus* noteth it, who would referre it to the *Acanthus Aegyptia* of *Athanaeus*; . . ."

According to Wood in Rees 1 (1802), Virgil had two different plants under this name (*Acanthus*). Wood continued:

"The *acanthus* with which he adorns the handles of Alcimedon's cups, in the 3d Eclogue, and places in the Corycian's garden, in the 4th *Georgic*, and the Egyptian *acanthus* of Theophrastus, are two very different plants. Virgil mentions another *acanthus* as being an ever-green plant, and producing berries, or a small round fruit; *baccas semper frondentis acanthi*, are his words; and Theophrastus tells us, that his Egyptian *acanthus* is a prickly tree, and bears pods like those of beans . . . It is plain, that the *acanthus* of Theophrastus is the acacia, a tree, from some species of which we have the gum arabic now in use; and the *acanthus* of Virgil, mentioned in the places above cited, is a garden herb. . . The other *acanthus* mentioned by Virgil in the fourth Eclogue, and second *Georgic*, is the *acanthus* of Theophrastus."

Two important botanical works appeared during the 1st century A.D., namely, the Natural History of Pliny the Elder, and *De Materia Medica* of Dioscorides. The Natural History or *Historia Naturalis* of Pliny the Elder, Caius Plinius Secundus (A.D. 23–77), the distinguished Roman writer, is regarded as one of the most valuable relics of classical antiquity. The work is in effect a vast encyclopaedic compilation in Latin from the writings of Greek authors of the knowledge of his time and contains a large section devoted to plants.

Pliny made the following reference to *Acacia*:

"In the same countrey there groweth a thornie plant, which the inhabitants make great account of: and especially that which is in colour blacke, because it will abide the water, and never rot nor putrifie in it: and therefore excellent good for the ribs and sides of ships. As for the white thorn of this kind, it will soone corrupt and be rotten. But both the one and other, is full of prickles even to the very leaves. The seed lieth in certain cods or huskes, wherewith curriers use to dresse their leather instead of gals. The flower that this thorne beareth, is beautifull, whereof folke make faire guirlands and chaplets; profitable also besides and good for many medicines. Out of the barke of this tree there commeth a gum likewise. But the cheefest commoditie and profite that it yeeldeth is this, cut it down when you please, it will be a big tree againe within three yeares. It groweth plentifully about Thebes in Aegypt, among Okes, Olives and Peach-trees, for the space of three hundred stadia from Nilus: where the whole tract is all woods and forrests, and nathelesse well watered with fountaines and springs among." (Pliny the Elder, Natural History 13, 9; transl. Philemon Holland 1:390, 1601).

Rackham 4: 137 (1945) was of the opinion that the black-thorn is *A. nilotica* and suggested that the white-thorn may be *A. albidia*.

Philemon Holland 1: 391 continued with Chapter 11 of the 13th book of Pliny as follows:

"The best gum in all mens judgement is that which commeth of the Aegyptian thorne *Acacia*, having veines within of checkerworke, or traile like wormes, of colour greenish, and cleare withall: without any peeces of barke intermingled among, and sticking to the teeth as a man cheweth it. A pound thereof is commonly sold at Rome for three deniers."

Chapter 12 of the 24th book of Pliny contains a lengthy discourse on gums and their varied uses.

De Materia Medica of Pedanios Dioscorides (1st century A.D.), the celebrated Greek physician and botanist from Anazarba in Asia Minor, is an encyclopaedic herbal in which are described the plants then reputed to have healing properties. It provided a valuable record of Greek herb-lore being based on his own observations and experience and on the writings of others including Crateuas, personal physician to King Mithridates (120–63 B.C.) (Stearn, 1954). As Pliny noted, Crateuas not only wrote about herbs; he also painted them in colour.

No contemporary version of the manuscript survived but the work has descended to us by the copying of copies of yet earlier copies. Consequently there exist manuscript versions of varying ages, completeness, accuracy and authenticity. Of these illustrated manuscripts of Dioscorides's work, the most important is the Codex Aniciae Julianae (also known as the Codex Vindobonensis and Codex Constantino-politanus). This work was made at Constantinople about the year 512 A.D. as a gift for the lady Anicia Juliana, the daughter of Flavius Anicius Olybrius, Emperor of the West in the year 472. A number of the illustrations in the Codex Aniciae Julianae appear to be derived from those made by Crateuas about two thousand years ago.

In the facsimile edition of Dioscorides's Codex Aniciae Julianae published in Leiden in 1906 Book 1, Chapter 133 is translated as follows:

"Akakia. *Acacia* grows in Egypt. It is a Thorne, growing well neere to the bignesse of a tree, the fruit of it lying in cods as that of the Lupin."

After the work of Dioscorides there is little botanical history for about 1500 years. During this long period Dioscorides's herbal was venerated and uncritically accepted as the infallible authority. Then, in the sixteenth and seventeenth centuries, the correction and extension of Dioscorides's work became one of the main preoccupations of the many herbalists as a result of which numerous illustrated herbals were published.

THE PERIOD 1500–1754 A.D.

Among the first herbals to appear in which reference is made to *Acacia* or to plants referred to by this name was that of Otto Brunfels. The first edition of Brunfels's *Novi herbarii tomus II* was published by Johannes Schott in Strassbourg in 1531 and the following reference to *Acacia* and discussion on gum arabic appears on p. 9:

"ACACIA succus spinae crescentis in Aegypto. Resudat ex eo gummi quod Officinae gummi Arabicum, Celsus sine epitheto Gummi appellat. Vulgus Medicorum hodie ignorat quid sit *Acacia*, & pruna illa sylvestria quae in spinis proveniunt, pro vera *Acacia* interpretantur, gravi errore: cum ijs prorsus Dioscor. descriptio non respondeat. Sed de his alias."

According to Riddle, in Dictionary of Scientific Biography 4: 121 (1971), by 1544 approximately 35 editions of Dioscorides's translations and commentaries had been produced. The most illustrious edition was Pierandrea Mattioli's which was first published in Italian in Venice in 1544 under the title *Di Pedacio Dioscoride Anazarbeo libri cinque della historia & materia medicinale*. Reference to *A. nilotica* is found on p. 84, and the gradual improvement of this work occupied much of the remainder of Mattioli's life. It was translated into many languages and appeared in a long series of editions.

A Latin version entitled *Commentarii in sex libros Pedacii Dioscoridis* was published in Venice in 1554. Reference to *Acacia* appears on p. 113 and on p. 114 there is an illustration of "*Acacia altera*". However, the plant figured is not an *Acacia* but a member of Papilionaceae (tribe Genisteae).

Reference is made to *Acacia* on p. 129 of the edition published in 1560 and on p. 51 of the 1562 edition of the work. Once again, the plant figured in these editions is not an *Acacia* but a member of Papilionaceae. The illustration from the latter edition is reproduced here as Fig. 1.

The same papilionate was illustrated under *Acacia* on p. 64 of Mattioli's *Kreüterbuch* published in 1563, but there is some discussion devoted to gum arabic.

In yet another edition entitled *I Discorsi nelli sei libri di Pedacio Dioscoride Anazarbo della materia medicinale* published in 1581 after Mattioli's death, reference to *Acacia* and illustrations of "*Acacia prima*" and "*Acacia seconda*" appear on p. 162. Neither species illustrated is an *Acacia*: both are papilionates. The figure of "*A. seconda*" is the same as that which appeared on p. 114 of the 1554 edition under the name "*Acacia altera*". Two papilionates are illustrated under the name *Acacia* on pages 210–211 of the 1585 edition.



FIG. 1.—A species of papilionaceae illustrated under the name "Acacia" in Mattioli, *Commentarii in sex libros Pedacii Dioscoridis* 51 (1562).

A reference to *Acacia* (reproduced here as Fig. 2) appears on p. 741 of Rembert Dodoens's *Cruijkeboeck* published by Van der Loe in Antwerp in 1554. Dodoens's real name was Rembert van Joenckema and, according to Florkin in *Dictionary of Scientific Biography* 4: 138 (1971), he changed it to Dodoens (son of Dodo), Dodo being a form of the first name of his father. The name was latinized into Dodonaeus, from which the French further transformed it into Dodonée. The plant figured appears to be a species of *Acacia* and circumstantial evidence would suggest *A. nilotica* but it is not possible to identify it with any certainty.

Three years after the publication of this first Flemish edition, a French edition with numerous additions appeared under the title of *Histoire des plantes*, the translation being carried out by Charles de Escluse (Carolus Clusius). Dodoens supervised the production of this book and in view of the numerous corrections it is in reality a second edition of the *Cruijdeboek*. The French edition of 1557 was itself translated into English by H. Lyte in 1578 and appeared under the title "Dodoens, A Nievve herball, or historie of plantes". The reference to *Acacia* in this work appears on p. 685 where two species are illustrated. The illustration of "*Acatia Aegyptica*" is the same one as



FIG. 2.—A species of *Acacia* (possibly *A. nilotica*) illustrated in Dodoens, Crüijdeboek 741 (1554).

that which appeared in the first edition of the Crüjdeboek, while the other species figured under the name "Acatia altera" is a papilionate.

In 1576 Mathias de l'Obel (De Lobel or Lobelius) published his *Plantarum seu stirpium historia* in Antwerp which was in effect an enlarged version of his *Stirpium adversaria nova* published in 1570-1. De l'Obel devised a system of classification in which the different groups were distinguished by the characters of their leaves which was a significant advance on previous efforts. He thus distinguished roughly between the classes now known as monocotyledons and dicotyledons. Reference to *Acacia* is found on p. 536 where two species are illustrated (reproduced here as Fig. 3). The figure on the left, "Spina Acatiae . . .", is *A. nilotica*, the figure being similar to that which appeared on p. 741 of the first edition of Dodoens's *Cruijdboeck* in 1554 except that a fragment of a pod and a seed have been added. The figure on the right referred to as "*Acatia altera*" is a papilionate.

De l'Obel's work was translated into Flemish and published in 1581 in Antwerp under the title of *Kruydtoeck* where the same two species were illustrated on p. 110 under *Acacia*.



FIG. 3.—Illustrations of "Spina Acatiae . . ." (*A. nilotica*) and of "Acacia altera . . ." (a species of Papilionaceae) in de l'Obel, *Plantarum seu stirpium historia* 536 (1576).

In the first edition of Dodoens' *Stirpium historiae* pemptades sex sive libri xxx published by Christophe Plantin in Antwerp in 1583 reference to *Acacia* appears on pages 739–741. The first species is *A. nilotica*, the figure (reproduced here in Fig. 4) being identical to the figure which appeared on p. 536 of De l'Obel's *Plantarum seu stirpium historia* (see Fig. 3), and the second species figured under the name "Acacia altera" is a papilionate. The latter figure is similar to the figure which appeared in De l'Obel's work and was possibly based on it but is not identical. Dodoens, De l'Obel and Clusius permitted the use of their wood-blocks in each others work which explains the occurrence of the identical figure in the works of de l'Obel and Dodoens.

In the second edition of Dodoens' *Stirpium historiae* pemptades sex sive libri xxx published by C. Plantin in Antwerp in 1616 *A. nilotica* is discussed and illustrated on p. 752.

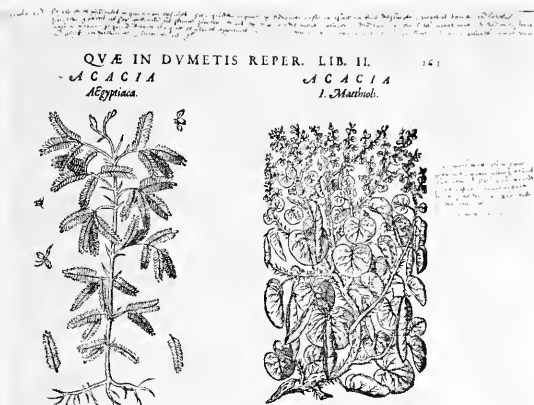
In 1587 the *Historia generalis plantarum*, sometimes referred to as *Historia plantarum lugdunensis*, a book which formed a compendium of much of the botany of the late sixteenth century, was published in Lyon. Although no author's name appears on the title page, the work is attributed to Jacques Daléchamps (Quinby



FIG. 4.—Illustrations of *Acacia* (*A. nilotica*) and "Acacia altera" (a species of Papilionaceae) in Dodoens, *Stirpium historiae* pemptades sex sive libri xxx 740 (1583).

1: 165, 1958; Stafleu & Cowan 1: 591, 1976). A detailed discussion and a summary of the knowledge of plants referred to *Acacia* up until this time appear on pages 160–163. The three species illustrated, namely, *Acacia Aegyptiaca*, *Acacia Matthioli* and *Acacia Altera Matthioli*, are reproduced here as Figs 5 & 6. Of the three, only *Acacia Aegyptiaca* is an *Acacia*, probably *A. nilotica*. The figure of this species is curious in that some of the blank spaces have been decorated with insects and falling leaves. The figure of *Acacia Altera Matthioli* is likewise decorated with insects.

In 1592 Prospero Alpini published a treatise in Venice entitled *De plantis Aegypti* which was a pioneer study of the Egyptian flora. Alpini, a doctor, accompanied the Venetian Consul, Giorgio Emo, to Egypt where he took advantage of the opportunity to study the local flora (Arber, 1938). Alpini's medical training led him to approach the new flora in the traditional manner of attempting to correlate the plants he encountered with the names and descriptions found in classical sources. However, when this was impossible, he described the plant under its local name and based the description upon specimens that he personally examined (Stannard in Dictionary of Scientific Biography 1: 124–125, 1970).



poco, ex quo femine in horro Patavino, aliisque quamplurimis Venerorum locis lato, orta est illa Acacia. Accipit & Morgagnus plantam nuper ex maris Occidendi infultu Peruvianis, ne quis putet peculiaritatem Aegypti aut Arabie. In nervulis prelongis foliola sunt Scorpioidis leguminis similes, anthraxe sferica cauallo nominata, in toto virgulto, gracili, aliquot rigida spinis in faucibus exsertis. Seminis tota siliqua non maior vno aleroe Lupino fimal nunctis, sed fuis alveolis distincta. Quare Matthiolus non Acaciam, sed fuis Spinam demas, arbori inda similem pictam dedisse videtur, cuius siliquae, fuae lobi non sunt Lupini similes, sed Genistae, duplo latiores, vrsenz compressae. Pene hic descripta vistor. Alcerum Acaciae genus, Aegypti Spinæ est famile, longe minus, tenerius, humile, aculeorum vallo munitum: Folia habet Rutæ: fermen Lenticulae, minus, in loculis convexis, ternum, quaternumque capacibus Acaciam altera genuina esse hic appiçdi censent Periti Herbarii, foliis Rutæ aut Cyrti, ternis, filiqua Gemistellæ, aut vulgaris Glycerhizæ, nouaculæ etigie, dorio obtusior, & altero latere, quasi acie acutior, tria aut quatuor etiam Gemistellæ femina dura continente, quæ nondum matura flauent, pollice nigricant. Hac Thyrsenum & Ligulicum, atque Medicreanum spinis fcatet, & pletrique alia Italiae loca. De Acacia, enique generibus hæc prodidit Theophrasti. Spina ex eo nomen accepit, quod tota arbor aculeis horreat, excepto caudice: nam & super germina, foliisque aculeos habet. Alitudo ne procer a sit, vt quæ ad duodecim cubitos penetret. Materies ex ea cedunt reseda idonea. Eius duo genera: quædam candida, quædam nigra. Candida imbecillis, & facile putrescent, nigra robustior, & incorrupta. Quare in naubis fabricandis ad eam cœlitur illa vniuntur. Recta non valde affligit, Fructus in liquo modo leguminum, quo incolat coria perficiunt Gallæ vice. Flos vique adeo aspectu pulcher, vt ex eo coronas faciant, est & medicamentis vtilis: quamobrem à medicis colligitur. Manat & Gummi ex ipsâ, tum vulnerata, tum sponte sine vlla plaga. Gummi.

FIG. 5.—Illustrations of "Acacia Aegyptiaca" (probably *A. nilotica*) and "Acacia Matthioli" (a species of Papilionaceae) in Daléchamps, *Historia generalis plantarum* 161 (1587).

Alpini discussed *A. nilotica* on pp. 4-6 and his t. 4 is reproduced here as Fig. 7. Inflorescences and fruits of *A. nilotica* were depicted for the first time in this figure so it represents a significant advancement on previous attempts to illustrate the species.

Some of Alpini's original descriptions were included in the writings of Linnaeus who regarded Alpini with sufficient esteem to name the genus *Alpinia* (Zingiberaceae) in his honour.

The year 1597 saw the publication by John Norton in London of the first edition of John Gerard's *The Herball* or *Generall Historie of Plantes*. It appears (Arber 129, 1938; Quinby 1: 188, 1958) that Norton had commissioned a Dr Robert Priest to translate Dodoens's *Stirpium historiae pemptades* sex, which was first published in 1583, but Dr Priest died before the work was published. His manuscript came into the possession of Gerard who altered Dodoens's arrangement to that of De l'Obel, added some of his own comments, and published the work as his own. De l'Obel was requested by the printer to correct Gerard's more obvious errors while the book was in the press, but Gerard's impatience with the corrections prompted him to stop De l'Obel and insist on immediate publication.

In his discussion of the "Aegyptian Thorne" on p. 1149 Gerard stated: "Dioscorides hath made mention of two sorts of *Acacia*, this whose figure we

have set downe is the right *Acacia*". However, the plant described and illustrated as "Acacia Dioscoridis, The Aegyptian Thorne" is in fact a papilionate and the same plant which was figured under the name "Acacia altera" in Dodoens's *Pemptades* (1583).

The 1633 edition of Gerard's *Herball* was enlarged and amended by Thomas Johnson who succeeded in correcting many of the errors in the 1597 publication. Two species are illustrated on p. 1330 of the 1633 edition. The illustration on the left "Acacia Dioscoridis. The Aegyptian Thorne" is of *A. nilotica*, the figure of the species being similar to that which appeared in Plantin's edition of Dodoens's *Stirpium historiae pemptades* in 1583. By changing the species illustrated under this name, Johnson succeeded in correcting the error made by Gerard. The illustration on the right "Acacia altera trifolia Thorny Trefoile" is the same species of Papilionaceae as that figured by Gerard in 1597 but a different illustration was used.

Aldinus, *Exactissima descriptio rariorum plantarum Romae in Horto Farnesiano* 2-7 (1625), provided, under the name *Acacia Indica Farnesiana*, a very detailed description and two illustrations of a plant in cultivation in the garden of Cardinal Farnese in Rome. The illustration on p. 2 (reproduced here as Fig. 8) shows the habit of the plant and the illustration

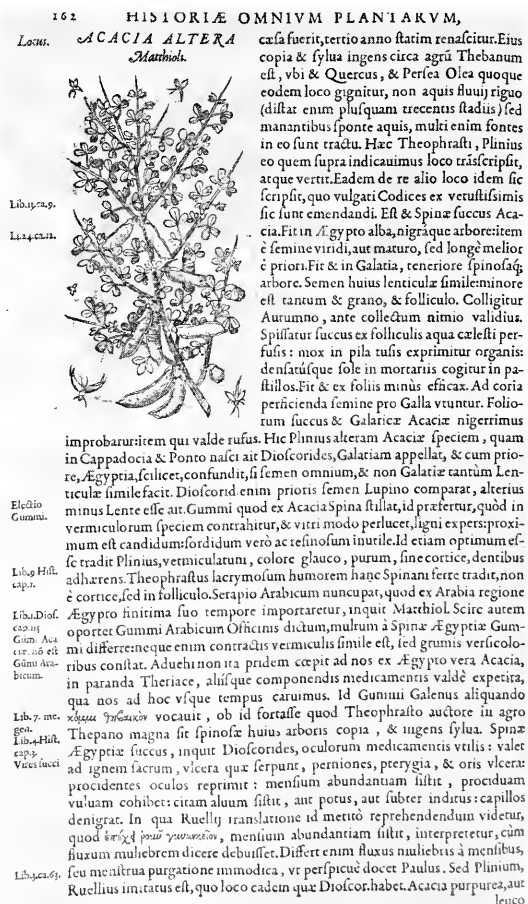


FIG. 6.—Illustration of "Acacia Altera Matthioli" (a species of Papilionaceae) in Daléchamps, *Historia generalis plantarum* 162 (1587).

DE PLANTIS AEGYPTI

ACATIA, SANT, ET KAKIA.

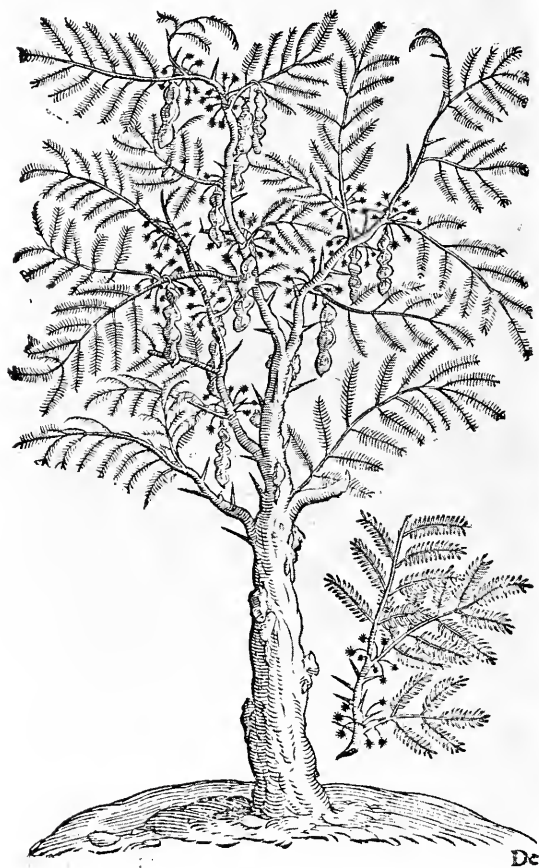


FIG. 7.—Illustration of "Acatia . . ." (*A. nilotica*) in Alpini, *De plantis Aegypti* t. 4 (1592).

on p. 4 (reproduced here as Fig. 9) is of a twig bearing flowers and fruits. Aldinus recorded that seeds of the plant were received from the island of St Domingo and were germinated in the year 1611. This appears to be the first direct reference to a species of *Acacia* indigenous to the western hemisphere or from an area other than the mediterranean or middle east.

The quality of the figure reproduced here as Fig. 9 greatly exceeded that of any previous illustration of an *Acacia* species, and of many which appeared in subsequent works. It is a faithful representation of the species now known as *Acacia farnesiana* and is of historical importance as reference to Aldinus's work is made by Linnaeus in the protologue of *Mimosa farnesiana* L. in his *Species Plantarum* ed. 1: 521 (1753), the basionym of *Acacia farnesiana* (L.) Willd., *Sp. Pl.* 4: 1083 (1806). Analysis of the protologue of *M. farnesiana* indicates that Linnaeus relied to some considerable extent on Aldinus's description and illustration of *Acacia Indica Farnesiana* for his concept of *M. farnesiana*, and that the epithet "farnesiana" was taken from Aldinus. In the absence of any specimen on which Linnaeus could have based his phrase-name of *M. farnesiana*, the

Aldinus plate reproduced here as Fig. 9 was selected as the lectotype of *A. farnesiana* (Ross, 1975b).

Aldinus discussed *A. aegyptiae* (*A. nilotica*) in detail on p. 7 of his work together with the characters that enabled the species to be distinguished from *Acacia Indica Farnesiana*.

It is perhaps as well to mention that there is some controversy over the authorship of the work here attributed to Aldinus. Pritzel, *Thesaurus Lit. Botanicae* ed. 2: 58 (1871), attributes the work to Castellus and notes "Operis 'Exactissima descriptio' autor est Petrus Castellus, atque falso sibi vindicavit Aldinus; typographus enim hisce etiam verbis: 'In gratiam Tobiae Aldini scripsi cuncta' profitetur, Aldinum auctorem non esse. Seguiet". Aldinus was Cardinal Farnese's physician and so the work may well have been dedicated to him. Saccardo, *La botanica in Italia*: 12 (1895), credits Aldinus with the work. In the *Catalogue of the Library of the British Museum (Natural History)* 1: 26 (1903) the work is attributed to Aldinus but there is a note reading "By some this has been considered to be really the work of P. Castelli."

The first edition of Caspar Bauhin's *Pinax theatri botanici* was published in 1623 in Basle. In this work, which included all of the plants known to western botanists up until this time, he listed for each species known to him all of the names (i.e. synonyms) that

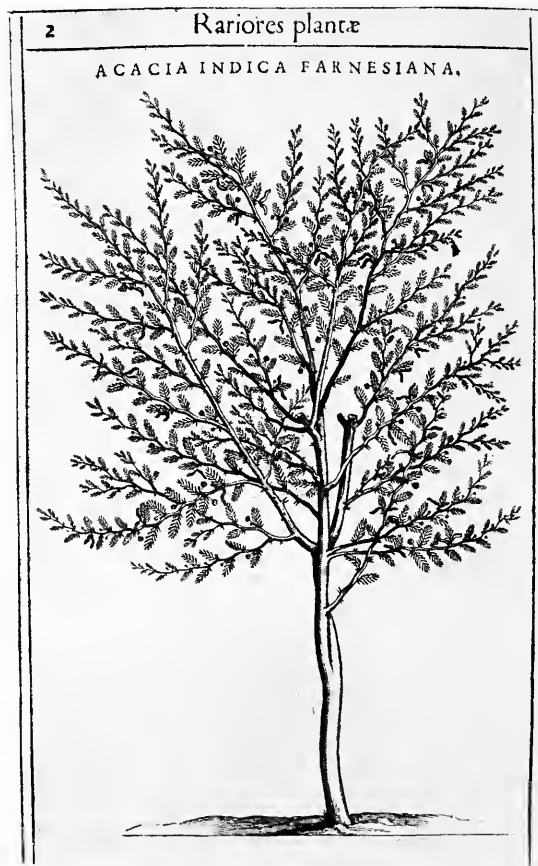


FIG. 8.—Illustration of the habit of "Acacia Indica Farnesiana" (*A. farnesiana*) in Aldinus, *Exactissima descriptio rariorum plantarum Romae in Horto Farnesiano* 2 (1625).

had been applied previously by earlier authors. Bauhin arranged the plants according to their natural affinities as he saw them and not merely in alphabetical order. A description of the genus *Acacia* appears on p. 391 and reference is made on p. 392 to two species, namely, "1. *Acacia foliis scorpioidis leguminosae* . . ." (i.e. *A. nilotica*), and "2. *Acacia trifolia* . . ." (i.e. a papilionate). Linnaeus drew heavily on Bauhin's *Pinax* and made constant reference to it in his *Species Plantarum*.

Volume 1 of Jean Bauhin's major botanical work, *Historia plantarum universalis*, was published in 1650 after his death under the co-authorship of J. H. Cherler and D. Chabrey (Stafleu & Cowan, 1976). A generic description of *Acacia* and a long dissertation appear on p. 426, and on p. 429 there is a description and illustration of *Acacia vera* (reproduced here as Fig. 10). The upper figure was clearly based on the illustration (t. 4) in Alpin's *De plantis Aegypti* (1592) which is reproduced here as Fig. 7. This upper figure featured by Bauhin was in turn reproduced in Duplain's *Historie des plantes de l'Europe 2: 715* (1737) under the name *Acacia Aegyptica*.

The year 1635 saw the publication in Paris of J.-P. Cornut's *Canadensium plantarum, aliarumque nondum editarum historia* which contains an early record of about 30 north-east American plants. The



FIG. 9.—Illustration of "Acacia Indica Farnesiana" (*A. farnesiana*) in Aldinus, *Exactissima descriptio rariorum plantarum Romae in Horto Farnesiano* 4 (1625).



FIG. 10.—Illustration of *Acacia vera* (*A. nilotica*) in J. Bauhin, *Historia plantarum universalis* 1: 429 (1650).

Acacia Americana Robini described on p. 171 and illustrated on p. 172 is *Robinia pseudo-acacia*.

John Parkinson's *Theatrum Botanicum* was published in London in 1640. Parkinson, who was honoured with the title of Herbalist to Charles I, took advantage of Bauhin's *Pinax* which enabled him to give the detailed nomenclature of each plant, and in this respect his work shows improvements on Gerard's *Herbal*. However, the rudimentary system of classification adopted by Parkinson was inferior to the system used by De l'Obel or Bauhin and serves to illustrate the lack of progress made in classification by the herbalists.

Parkinson's discussion of *Acacia* commenced on page 1547 as follows:

"*Dioscorides* hath made mention of two sorts of *Acacia*, the one of *Egypt*, and the other of *Cappadocia*, and *Pontus*: *Theophrastus* also speaketh of two sorts, blacke and white: that of *Egypt* is reasonable well knowne, but of that sort of *Pontus*, there is some controversie among Writers, some taking one bush to be it, and others denying it to be it, the differences of *Theophrastus* sorts are onely expressed in the wood, . . ."

Parkinson recognized and provided descriptions of three species. The first species enumerated was

"*Acacia sive Spina Aegyptiaca vera*. The true *Acacia*, that is Egyptian thorne or binding Beane tree" (i.e. *A. nilotica*), and the illustration which accompanied his description is reproduced here as Fig. 11. His description reads as follows:

"The Egyptian Thorne groweth in some places to be a great tree, and rather crooked then straight or rising high, covered with a blackish bark, spreading abroad great armes and branches, full of sharp thornes, with many winged leaves set on both sides of them, that is, with foure wings of leaves on a side, made of sundry small ones, set opposite on a middle rib, without any odde one at the end, although it be so expressed, *Bellonius* saith that he counted 350 of those small leaves, that were upon the whole branch, and yet all of them might but cover his thumbe: the flowers grow among the branches, like flockes of wooll, of a whitish yellow colour, where after come somewhat large and thicke huskes, like unto the *Lupine* or flat beane cods, blacke when they are ripe, and bunched forth against the places where the seedes lye, in some three or foure, and in some more, each as bigge as a small wild Beane, round, and of a grayish or ash-colour, almost shining: the tree abideth alwayes with greene leaves thereon, and yeeldeth of it owne accord a white gumme in small curled peeces like great wormes, and greater round peeces if it be wounded."

The second species described was "*Acacia Americana Farnescena*. The West Indian *Acacia* or binding Beane tree" (i.e. *A. farnesiana*), and the illustration of it is reproduced here in Fig. 11. It is at once apparent that this figure of *A. farnesiana* was based on the figure first published by Aldinus (1625). The third species, namely, "*Acacia secunda sive altera Dioscoridis*, The true second *Acacia* of *Dioscorides*" is a papilionate.

Herbaria Nuovo by Castore Durante was first published in Rome in 1585. The work was translated and reprinted for many years and the reference to *Acacia* on p. 3 of the edition published in Venice in 1667 is reproduced here as Fig. 12. It will be noticed that the description of *Acacia del Matthioli* (which is a

papilionate and not an *Acacia*) is written in the form of a poem. *Acacia D'Egitto* is probably *A. nilotica*.

A good illustration of *A. farnesiana*, similar to the one originally published by Aldinus (1625), appeared under the name "*Acacia Americana*" in Plate 35 of Abraham Munting's *Waare Oeffening der Planten* (1672) and the plants referred to the genus *Acacia* were discussed on p. 32.

A discussion of *Acacia vera* (i.e. *A. nilotica*) appeared on p. 398 of F. Hoffmann's *Clavis Pharmaceutica Schroederiana* (1681), while reference was made on p. 399 to *Acacia Germanica* (i.e. *Prunus sylvestris*).

And now, for the first time, our attention turns to the southern hemisphere. During his stay at the Cape of Good Hope, the High Commissioner Hendrik Adriaan van Reede tot Drakenstein, Lord of Mydrecht, authorized the Commander, Simon van der Stel, to explore the Copper Mountains of Namaqualand (Reynolds, 1950). Van der Stel's expedition left on 25th August 1685 and reached the Copper Mountains some 300 miles to the north on 21st October. The expedition returned to the Cape on 26th January 1686 after exploring part of the coast. It may be assumed that the artist Hendrik Claudius was a member of Van der Stel's party and to him are attributed the seventy-one pages of coloured drawings including those of plants encountered during the expedition.

The official record of Van der Stel's expedition to Namaqualand was removed from the Dutch East India Company's Archives in 1691 or 1692, and all trace of the manuscript ('Dag Register') was lost until 1922 when it was identified by Professor G. Waterhouse in the Catalogue of the Fagel Collection acquired by Trinity College, Dublin in 1802. The first part of the manuscript consists of the Journal of

1. *Acacia vera sive Spina Aegyptiaca*.
The Egyptian Thorne or binding beane tree.

2. *Acacia Americana Farnesiana*.
The West Indian *Acacia* or binding beane tree.

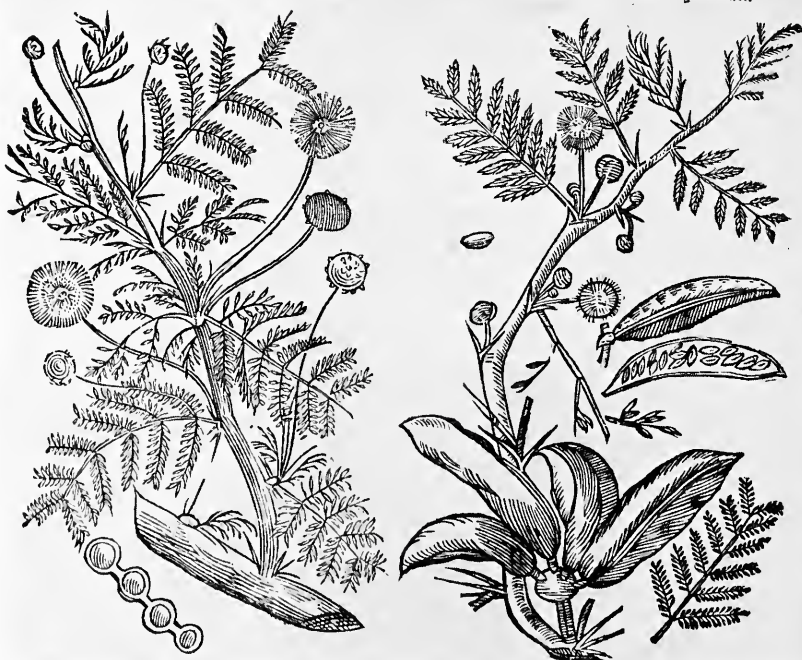


FIG. 11.—Illustrations of "*Acacia vera sive spina Aegyptiaca*" (*A. nilotica*) and "*Acacia Americana Farnesiana*" (*A. farnesiana*) in Parkinson, *Theatrum Botanicum* 1548 (1640).



FIG. 12.—Illustrations of "Acacia del Matthioli" (a species of Papilionaceae) and "Acacia D'Egitto" (possibly *A. nilotica*) in Durante, *Herbaria Nuovo* 3 (1667).



807. ACACIA GIRAFFAE Willd. (?).

FIG. 13.—Illustration of an "Acacia" of unknown identity attributed to Claudius (T.C.D. No. 807). (Reproduced from Waterhouse, Simon van der Stel's Journal of his Expedition to Namaqualand 1685-6).

the expedition, and the second part of the coloured drawings. In 1932 Waterhouse published a book on Van der Stel's expedition to Namaqualand which included half-tone reproductions of the Claudius drawings.

One of the plants illustrated on Van der Stel's expedition (TCD No. 807) is reproduced here as Fig. 13.

A translation of the notes accompanying the drawing TCD No. 807 (Waterhouse, 1932) reads as follows:

"This tree grows in such abundance in Namaqualand that almost all the forests are composed of it. On account of its multitude of hurtful thorns we call it Thorn Tree, whereas the natives call it *Chõe*. It is moderately tall and large but crooked, and it has good, hard, useful wood. It is found only along rivers and brooks. Its flowers have a remarkably pleasant smell and they are followed by a pod containing a few flat seeds, the effects of which are so far unknown."

Along the route followed by the Van der Stel expedition Claudius would certainly have encountered the plant that is now known as *Acacia karroo* Hayne. The only other *Acacia* species armed with paired stipular spines and with flowers in round heads that he may possibly have encountered was *A. erioloba* E.

Mey. However, the illustration attributed to Claudius (Fig. 13) bears little actual resemblance to *A. karroo*, to *A. erioloba*, or to any other South African *Acacia* species. The leaves are shown to be consistently imparipinnately compound whereas in all of the indigenous South African *Acacia* species the leaves are always paripinnately compound, and the pods illustrated are at variance with those of *A. karroo* and of *A. erioloba*. Father Tachard, who visited the Cape in 1685, is quoted by Karsten 89 (1951), as having said of Claudius that "He draws and paints animals and plants to perfection." As Claudius was an artist of such high repute it seems odd that his illustration is inaccurate in several obvious and significant respects and bears so little actual resemblance to any of the *Acacia* species. That is, of course, if the painting was executed by Claudius and at present there is no reason to doubt that it was not.

The figure published by Plukenet in his *Phytographia* t. 123, fig. 2 (1692), and reproduced here as Fig. 14, is almost identical to the illustration executed by Claudius on the Namaqualand expedition. Plukenet's illustration differs chiefly in that it has been reversed from left to right, i.e. the leaves, inflorescences and pods are depicted facing in the other direction. In addition, Plukenet has added a loose inflorescence, a loose pod and two more loose

seeds. The Claudius drawings are known to have been copied and the copies copied and a set of drawings was presented to Henry Compton, the Right Reverend the Bishop of London from 1675–1713, while his lordship was attending a Congress in Amsterdam in 1691. Both Petiver and Plukenet had access to the drawings in Bishop Compton's possession. The close similarity between the Claudius and Plukenet illustrations suggests that Plukenet copied Claudius's drawing; no specimen on which Plukenet could have based the illustration has been located in the Sloane Herbarium in the British Museum (Natural History), although this does not, of course, provide proof that Plukenet copied the Claudius illustration. It does, however, strengthen the argument that Plukenet copied an illustration and not an actual specimen. *Aloe* and *Gladiolus* paintings prepared by Claudius are known to have been copied by Petiver and by Plukenet (Reynolds, 1950; Lewis et al., 1972) and it is therefore a reasonable assumption that the Plukenet figure reproduced here as Fig. 14 was also copied.

The identity of the plant depicted by Claudius (Fig. 13) and subsequently copied by Plukenet remains uncertain which is unfortunate because *Mimosa capensis* Burm.f., Prodr. Fl. Cap. 31 (sphalm. 27) (1768) was based on Plukenet t. 123, fig. 2. This inability to positively identify the plant depicted has led to the name *Mimosa capensis* being rejected as a name of uncertain application (Verdoorn, 1954; Ross, 1971, 1975a).

It is interesting and perhaps significant that the plant depicted by Plukenet in his *Phytographia* t. 123, fig. 1 (see Fig. 14) is *A. karroo*. The figure was based on a sterile twig of *A. karroo*, Herb. Sloane Vol. 99, fol. 3 in the British Museum (Natural History), and is a good representation of it.

Plukenet's *Phytographia* t. 123, fig. 1, was cited by Plukenet in his *Almagestum botanicum* 3 (1696) under

Acacia vera, by Linnaeus, Species Plantarum 1: 521 (1753), in synonymy under *Mimosa scorpioides*, and by Burm.f., Prodr. Fl. Cap. 31 (1768), under the name *Mimosa nilotica*, but in each case it was an incorrect identification.

The first volume of John Ray's *Historia Plantarum*, which contains descriptions of all plants then known, was published in London in 1686. The natural system employed by Ray depended in part on the differences on the formation of the embryo, that is, plants were divided roughly into monocotyledons and dicotyledons. "*Acacia vera* J.B." is discussed in some detail on p. 976 and there is reference to gum arabic, and "*Acacia Indica Farnesiana Aldini*" is discussed on the following page.

Horti academici lugduno-batavi catalogus by Paul Hermann, the director of the Leiden Botanic Garden from 1679–1695, was published in Leiden in 1687. Hermann considered two of the species referred to *Acacia* by previous authors, namely *Acacia trifolia* and *Acacia Germanica* vulgo, to be sufficiently distinctive to exclude them from his concept of the genus, although he retained *Acacia Americana* (i.e. *Robinia pseudo-acacia*) in the genus *Acacia*.

Further reference to *Acacia* appears on page 36 of Jacob Breyne's *Prodromus fasciculi rariorum plantarum secundus*, which is in effect a catalogue of plants observed by the author in gardens in Holland, published in Danzig in 1689.

Leonard Plukenet's *Phytographia* was published in three parts in London in 1691–2 and species referred to *Acacia* are illustrated in plates 121–123. Plukenet's works are of importance for purposes of typification because Linnaeus frequently cited them in his *Species Plantarum*, making reference to Plukenet's illustrations which were usually based on specimens in the latter's herbarium (now part of the Sloane Herbarium in the British Museum). Many of the species described by Linnaeus were known to him only by Plukenet's figure and brief descriptive note.

The plants illustrated in figures 3–6 of Plate 121 of Plukenet's *Phytographia* were referred to *Acacia*. Linnaeus, Sp. Pl. 1: 521 (1753), based his *Mimosa horrida*, the basionym of *Acacia horrida* (L.) Willd., Sp. Pl. 4: 1082 (1806), on Plukenet's *Phytographia* t. 121, fig. 4 (1692). The descriptive phrase quoted by Linnaeus "*Acacia maderaspatana, foliis parvis, aculeis e regione binis praegrandibus horrida, cortice cinereo*" appeared at the foot of Plukenet's plate, and was repeated, without additional information, in Plukenet's *Almagestum botanicum* 3 (1696). Although Linnaeus never saw the actual specimen drawn, there is nothing in his diagnostic phrase that could not have been obtained from a study of Plukenet's figure. The specimen on which Plukenet's t. 121, fig. 4 was based, is preserved in the Sloane Herbarium Vol. 95, fol. 3 in the British Museum (Natural History). Plukenet's t. 121, fig. 5, was cited by Linnaeus, Sp. Pl. 1: 520 (1753), under *Mimosa cinerea* [i.e. *Dichrostachys cinerea* (L.) Wight & Arn.], but the identity of the other two plants referred to *Acacia* in t. 121 is uncertain.

Four species referred to *Acacia* were illustrated in t. 122 one of which, namely fig. 1, was cited by Linnaeus, Sp. Pl. 1: 520 (1753), under *Mimosa cornigera* [i.e. *Acacia cornigera* (L.) Willd., Sp. Pl. 4: 1080, 1806], and a further three in t. 123.

Reference has already been made to t. 123 fig. 1, the caption of which is as follows: "*Acacia Africana*,



FIG. 14.—Illustrations of "*Acacia Africana, spinis candicantibus horrida, . . .*" as t. 123 fig. 1 (*A. karroo*) and "*Acacia Africana, Abruae foliis, aculeata, . . .*" as t. 123 fig. 2 (identity unknown) in Plukenet, *Phytographia* (1692).

spinis candicantibus horrida, subrotundis foliis, odoratissima." The sterile twig depicted is referable to the species now known as *Acacia karroo*. This figure was later cited by Plukenet in his *Almagestum botanicum* 3 (1696) under *Acacia vera* as follows:

"Acacia vera, s. Spina Aegyptiaca, subrotundis foliis, flore luteo, siliqua brevi pauciorib. isthmis glabris, & cortice nigricantibus, donata . . . hujus *Icon* exhibetur in *Phytogr.* nostr. *Tab.* 123 *fig.* 1 sub titulo *Acaciae Africanae*, spinis candicantibus horridae, subrotundis foliis odoratissimae".

Reference has also been made to t. 123, fig. 2, which was apparently copied from a drawing prepared by the artist Claudius who accompanied Van der Stel on his expedition to Namaqualand in 1685 and represents a plant of unknown identity. Plukenet's caption to this figure "*Acacia Africana*, *Abruae* foliis, aculeata, spinis longissimis horrida. . . ." was repeated in his reference to the species in *Almagestum botanicum* 3.

Plukenet made reference in his *Almagestum botanicum* 3 (1696) under the name *Acacia altera vera* (i.e. *A. nilotica*) to the illustration of the species which appeared in his *Almagestum botanicum* as t. 251, fig. 1, in 1694 (reproduced here as Fig. 15). This figure was cited by Linnaeus, in *Hortus Cliffortianus* 209 (1738), under the name "*Mimosa spinis geminatis, foliis duplicato-pinnatis*" and later in the synonymy of *Mimosa senegal*, in *Sp. Pl.* 1: 521 (1753), which illustrates that to his earlier concept of a species armed with paired spines in *Hortus Cliffortianus* Linnaeus subsequently added in the *Species Plantarum* the diagnostic phrase name of a species armed with spines (actually prickles) in threes.

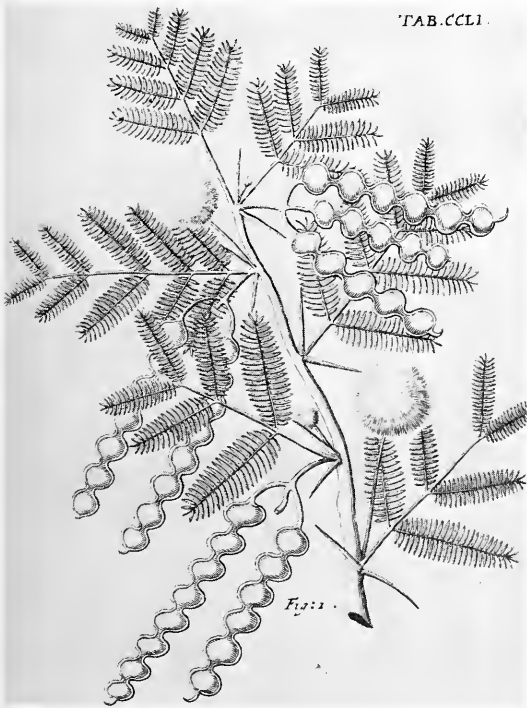


FIG. 15.—Illustration of "*Acacia altera vera*" (*A. nilotica*) in Plukenet *Almagestum botanicum* t. 251 fig. 1 (1694).



FIG. 16.—Illustration of "*Acacia similis, spinis corniformibus mexiocana*" (*A. cornigera*) in J. Commelin, *Horti medici amstelodamensis* 1 t. 107 (1697).

The year 1689 saw the publication of Jan Commelin's *Catalogus plantarum horti medici amstelodamensis* in Amsterdam. In this catalogue of the Amsterdam Physic Garden, of which Jan Commelin was Director, the plants are arranged alphabetically and on pages 3–4 four species of *Acacia* were listed. Of these, only the first two are referable to *Acacia*, namely, "*Acacia vera* J. Bauh. . . ." (i.e. *A. nilotica*) and "*Acacia indica Farnesiana* . . ." (i.e. *A. farnesiana*).

In 1697 volume 1 of Jan Commelin's *Horti medici amstelodamensis* was published posthumously by his nephew Caspar Commelin in Amsterdam. In this fine work figures 105–107 were devoted to *Acacia*, but of the three figures only the latter is readily identified as a species of *Acacia*. Figure 107, which is reproduced here as Fig. 16, depicts under the name "*Acacia similis, spinis corniformibus mexiocana*" one of the swollen-thorn *Acacia* species grown from seed collected in Cuba. As indicated by Blunt (137, 1955), the illustration of this *Acacia*, like many of the plants figured, rises stiffly from the soil and masquerades as a little tree. The figure in question was cited by Linnaeus under *Mimosa cornigera* in his *Species Plantarum* 1: 520 (1753). Commelin compared the plant with *Acacia Americana* Aldini (i.e. *A. farnesiana*) and discussed the reports of the small black ants associated with the swollen spines.

The three volumes of J.P. Tournefort's *Institutiones rei herbariae*, editio altera with fine copper engravings by Claude Aubriet, one of the classics of systematic botany, were published in 1700 in Paris, a work described as a second edition of his *Éléments de botanique* published in 1694. Tournefort adopted the concept of genera and species formulated by Caspar Bauhin but, unlike Bauhin, he placed the main emphasis on the genus. Whereas Bauhin gave only the name of the genus and supplied the species with descriptions, Tournefort consistently provided the genera with names and descriptions and added the species without providing special descriptions. Tournefort distinguished genera primarily on the characters of the corolla and fruit but he also accepted genera differing from allied genera by vegetative characters which he termed 'genera of second rank.' A generic description of *Acacia*, and of *Mimosa*, is given on p. 605 of Volume 1 together with an enumeration of species, and both genera are illustrated in t. 375 of Volume 3 of the work.

The two volumes comprising Hermann Boerhaave's *Index alter plantarum quae in horto academico Lugdano-Batavo* were published in Leiden in 1720. On p. 56 of the second volume the genus *Acacia* is attributed to Tournefort and twelve species are enumerated under the genus, some of which belong to other genera.

An alphabetical list of the plants in the Botanical Garden at Pisa is contained in *Catalogus plantarum horti Pisani* by Michele Angelo Tilli published in Florence in 1723. Several species of *Acacia* are discussed on p. 2 of the catalogue and illustrations appear in Plate 1.

The year 1737 saw the publication in Regensburg of the first volume of Johann Weinmann's *Phytanthoza Iconographia*. A generic description of *Acacia* appears on p. 8 and several species attributed to *Acacia* are enumerated, many of which belong to other genera. A hand-coloured illustration of *A. nilotica*, referred to as "*Acacia Aegyptiaca Vera*" is figured in t. 10.

Another work which appeared in 1737, in addition to the first edition of Linnaeus's *Genera Plantarum*, was *Thesaurus Zeylanicus* by Johannes Burman published in Amsterdam. Plants are arranged in alphabetical order in this work and the enumeration of species referred to *Acacia* appears on pp. 2-6. Burman used polynomials and the first species described on p. 2 under the name "*Acacia aculeata, multiflora, foliis pennas avium referentibus*" and illustrated in Table 1 (reproduced here as Fig. 17) is *Acacia pennata* (L.) Willd. Linnaeus cited this plate under *Mimosa pennata* in his *Sp. Pl.* 1: 522 (1753). The other *Acacia* illustrated in Table 2 under the name "*Acacia spinosa ex alis spicata, foliis pennas avium referentibus*" is *Dichrostachys cinerea* (L.) Wight & Arn. and the plate was cited by Linnaeus *l.c.*: 520 under *Mimosa cinerea*. Many of the other species referred to *Acacia* belong to other genera.

In an appendix to the *Thesaurus Zeylanicus* (1737), *Catalogi duo plantarum africanorum*, Burman listed a number of plants collected at the Cape by Hermann among which were three *Acacia* species. The second of these referred to as "*Acacia Africana, angustifolia, spinis majoribus, flore odoratissimo. Acacia Africana, spinis candicantibus horrida Plukn.*" is apparently *A. karroo*, but the identity of the other two is not clear from the descriptions.

In Adrian van Rooyen's *Florae Lugdensis Prodromus* published in Leiden in 1740, which comprises

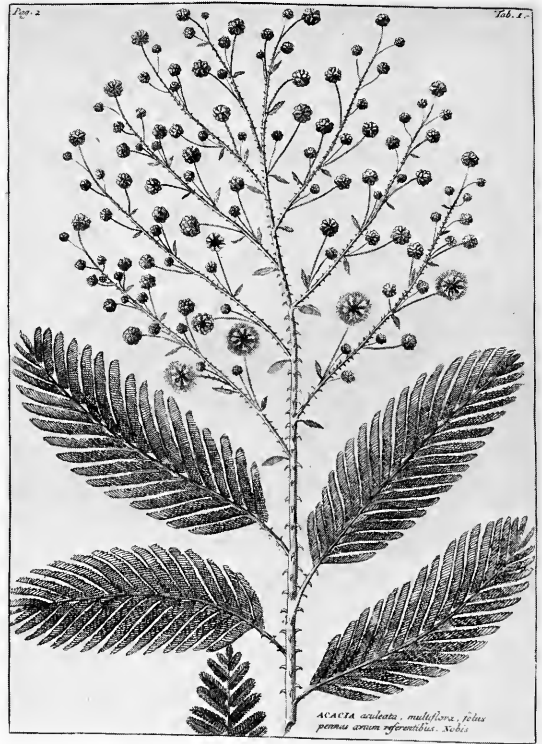


FIG. 17.—Illustration of "*Acacia aculeata, multiflora, foliis pennas avium referentibus*" (*A. pennata*) in J. Burman, *Thesaurus Zeylanicus* t. 1 (1737).

a list of the plants in the Leiden Botanical Garden, the genus *Acacia*, along with the genus *Inga*, was treated as a synonym of *Mimosa* in keeping with the generic concept adopted by Linnaeus.

Linnaeus did not employ the name *Acacia* in a generic sense in the first edition of his *Genera Plantarum* published in 1737 (or in subsequent editions in 1742, 1743, 1752, 1754 or 1764), in *Hortus Cliffortianus* (1738), *Hortus Upsaliensis* (1748), in the first edition of *Species Plantarum* in 1753 or in the second edition of 1763. In these publications the genus was relegated to synonymy under *Mimosa*, and in the synonymy of *Mimosa* in *Genera Plantarum* Linnaeus attributed the genus *Acacia* to Tournefort. Linnaeus had a much broader generic concept than Tournefort and some of his successors being influenced primarily by characters of the androecium and gynoecium.

Linnaeus did use *Acacia* in a generic sense in his *Flora Zeylanica* 217 (1747) and his name has been associated with the genus from this publication. However, as this was prior to 1753, the starting point of modern botanical nomenclature, the genus *Acacia* L. has no standing in present nomenclature.

Philip Miller (*Gard. Dict. abridg.* ed. 4, 1754) was the first author to employ the name *Acacia* in a generic sense subsequent to 1753 and is, therefore, regarded as the author of *Acacia*. Philip Miller used the name *Acacia* in a generic sense from the first edition of his *Gardeners Dictionary* in 1731 to the seventh edition in 1759, and in the first to the fifth abridged editions published between 1735 and 1763. Miller's taxonomic knowledge was considerable and

he was slow to accept Linnaeus's views on nomenclature and classification. Although the first edition of Linnaeus's *Genera Plantarum* was published in 1737 and the first edition of *Species Plantarum* in 1753, Miller did not accept all of Linnaeus's generic and specific concepts uncritically, but retained as distinct many genera defined by Tournefort and suppressed by Linnaeus. It is largely on account of his departures from Linnaeus's concepts that Miller's works published subsequent to 1753 derive their nomenclatural importance (Stearn, 1969).

In the seventh edition of *The Gardeners Dictionary* (1759) Philip Miller adopted the phrase-names from Linnaeus's *Species Plantarum* wherever applicable and provided new ones where required for species not known to Linnaeus. Miller wrote under his treatment of the genus *Acacia* in the seventh edition:

"Dr. Linnaeus has joined the plants of this genus, and also the *Inga* of Plumier, to the *Mimosa*, or sensitive plant, whereby he has multiplied the number of the species greatly, and occasioned some confusion. I shall choose, therefore, to refer them to their former genera again; for as all sorts of *Mimosa* have articulated pods, and their leaves move on being touched, so the *Acacias*, which have neither of these properties, may very reasonably be made a distinct genus, and hereby the ancient official name will be preserved."

He then proceeded to enumerate the characters of the genus *Acacia*.

It was not until the eighth edition of *The Gardeners Dictionary* in 1768 that Miller finally accepted Linnaeus's binomial nomenclature for species. In his preface of this edition he stated:

"In the last edition of this work, the author adopted in a great measure the system of Linnaeus, which was the prevailing method of ranging plants then in use among botanists; but as many of the plants which were treated in the *Gardeners Dictionary*, were not to be found in any of Linnaeus's works then published, Tournefort's system was also applied to take in such as were not fully known to Dr Linnaeus; but since that time the learned professor having made great additions to his works, and those additions being generally consulted for the names of plants, the author has now applied Linnaeus's method entirely, except in such particulars, where the Doctor not having had an opportunity of seeing the plants growing, they are ranged by him in wrong classes, . . ."

Thus Miller belatedly converted to Linnaeus's system in the eighth edition of his *Dictionary* and relegated *Acacia* to synonymy under *Mimosa* where he noted:

"The *Acacias* are so nearly allied to the *Mimosas* in their characters, that Linnaeus has joined them in the same genus; and as his system is now generally followed, so in compliance with that I have done the same."

Subsequent authors did not follow Linnaeus's broad generic concept and treated *Acacia* and *Mimosa* as distinct genera, although the limits of the genera remained ill-defined for a long time. The generic limits of *Acacia* were finally clarified by Bentham (1842) and have not been seriously in doubt since.

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UITTREKSEL

Die voor-Linnaeiese geskiedenis van die plante toegewys aan die genus Acacia weerspieël in 'n sekere mate die ontwikkeling van botaniese beskrywing, klassifikasie en illustrasie. Aandag word gevestig op sommige van die vroegste verwysings na plante bekend as behorende tot die genus Acacia en op verwysings in uitgekose kruidenboeke en publikasies tot met Philip Miller se beskrywing van die genus in die vierde verkorte uitgawe van sy Gardeners Dictionary in 1754.

REFERENCES

- ARBER, A., 1938. *Herbals, their origin and evolution; a chapter in the history of botany, 1470-1670*. 2nd ed. Cambridge: Cambridge University Press.
- BENTHAM, G., 1842. Notes on Mimoseae, with a synopsis of species. *Hook., Lond. J. Bot.* 1: 318-392.
- BLUNT, W., 1955. *The art of botanical illustration*. 3rd ed. London: Collins.
- BLUNT, W., 1958. The illustration of early botanical works. In J. Quinby, *Catalogue of botanical books in the collection of Rachel McMasters Miller Hunt* 1: xli-xlvii. Pittsburgh: Hunt Botanical Library.
- FELIKS, J., 1971. *Acacia*. In *Encyclopaedia Judaica* 2: 198-199. Jerusalem: Keter Publishing House.
- FLÜCKIGER, F. A. & HANBURY, D., 1874. *Pharmacographia—a history of the principal drugs of vegetable origin* pp. 206-216. London: Macmillan & Co.
- FUCHS, L., 1542. *De historia stirpium commentarii insignes*. Basel.
- FULTON, J. F., 1958. Medical aspects of early botanical works. In J. Quinby, *Catalogue of botanical books in the collection of Rachel McMasters Miller Hunt* 1: xxxii-xxxv. Pittsburgh: Hunt Botanical Library.
- KARSTEN, M. C., 1951. *The Old Company's Garden at the Cape and its superintendents*. . . . Cape Town: Maskew Miller.
- LEWIS, G. J., OBERMEYER, A. A. & BARNARD, T. T., 1972. A revision of South African species of *Gladiolus*. *Jl S. Afr. Bot.*, Suppl. Vol. 10. Cape Town: Purnell.
- MOLDENKE, H. N. & MOLDENKE, A. L., 1952. *Plants of the Bible*. Waltham: Chronica Botanica Company.
- PARKINSON, J., 1640. *Theatrum Botanicum*, London.
- QUINBY, J., 1958. *Catalogue of botanical books in the collection of Rachel McMasters Miller Hunt* 1. Pittsburgh: Hunt Botanical Library.
- RACKHAM, H., 1945. *English translation of Pliny's Natural History*, Vol. 4.
- REES, A., 1802. *The cyclopaedia; or universal dictionary of arts, sciences and literature* 1. London.
- REYNOLDS, G. W., 1950. *The aloes of South Africa*. Johannesburg: the Aloes of South Africa Book Fund.
- RICKETT, H. W., 1958. Botany from 840 to 1 700 A.D. In J. Quinby, *Catalogue of botanical books in the collection of Rachel McMasters Miller Hunt* 1: xxiii-xxxi. Pittsburgh: Hunt Botanical Library.
- ROCHEBRUNE, A. T. de, 1899. *Toxicologie Africaine* 2. Paris.
- ROSS, J. H., 1971. *Acacia karroo* in Southern Africa. *Bothalia* 10: 385-401.
- ROSS, J. H., 1975a. Notes on African *Acacia* species. *Bothalia* 11: 443-447.
- ROSS, J. H., 1975b. The typification of *Mimosa farnesiana* L. *Bothalia* 11: 477-472.
- SACHS, J. von, 1890. *History of botany, 1530-1860*. Translated from the German by H. E. F. Garnsey and revised by I. B. Balfour. Oxford: Clarendon Press.
- SMITH, W. & FULLER, J. M. (eds), 1893. *A dictionary of the Bible comprising its antiquities, biography, geography and natural history*. 2nd ed. London: Murray.
- STAFLEU, F. A., 1967. *Taxonomic literature*. Regnum Vegetabile. Vol. 52. Utrecht: IAPT.
- STAFLEU, F. A., 1969. Miller's 1754 *Gardeners Dictionary*. *Taxon* 18: 713-715.

- STAFLEU, F. A. & COWAN, R. S., 1976. *Taxonomic literature*. 1: A-G. Regnum Vegetabile Vol. 94. Utrecht: Bohn, Scheltema & Holkema.
- STEARNS, W. T., 1954. Codex Aniciae Julianae: the earliest illustrated herbal. *Graphis (Zurich)* 10: 322-329.
- STEARNS, W. T., 1957. *An introduction to the Species Plantarum and cognate botanical works of Carl Linnaeus*. Prefix to the Ray Society facsimile of the first edition of Linnaeus's Species Plantarum 1753. London: Ray Society.
- STEARNS, W. T., 1958. Botanical exploration to the time of Linnaeus. *Proc. Linn. Soc. Lond.* 169: 173-196.
- STEARNS, W. T., 1961. Botanical gardens and botanical literature in the eighteenth century. In A. Stevenson, *Catalogue of botanical books in the collection of Rachel McMaster Miller Hunt* 2, 1: xlii-cxl. Pittsburgh: Hunt Botanical Library.
- STEARNS, W. T., 1969. Introduction to Philip Miller, *The Gardener's Dictionary* (Abridged Ed. 1754). Lehre, Germany: Verlag von J. Cramer.
- STEVENSON, A., 1961. *Catalogue of botanical books in the collection of Rachel McMaster Miller Hunt* 2. Pittsburgh: Hunt Botanical Library.
- VERDOORN, I. C., 1954. The nomenclature of the Cape *Acacia*. *Bothalia* 6: 409-413.
- WATERHOUSE, G., 1932. *Simon van der Stel's journal of his expedition to Nannakaland, 1685-6*. London.

The genus *Sypharissa* (Liliaceae)

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ABSTRACT

The genus *Sypharissa* Salisb. (Liliaceae) is resuscitated and four species belonging to this genus are validly published.

RÉSUMÉ

LE GENRE SYPHARISSA (LILIACEAE)

On ressuscite le genre *Sypharissa* Salisb. (Liliaceae), auquel cette publication rattache validement quatre espèces.

A group of species in the Liliaceae, all bearing caudate floral bracts, has been variously placed under the genera *Drimia*, *Urginea*, *Urgineopsis*, *Thuranthos*, *Rhadamanthus*, *Rhodocodon* and *Litanthus*. In 1977 Jessop sank *Urginea*, *Urgineopsis* and *Thuranthos* under *Drimia*. However, the species now all placed under this genus form a most heterogeneous assemblage and further study may assist in arriving at a more satisfactory arrangement. It was observed that a group of related species placed in a separate genus by Salisbury (1866), differed sufficiently from *Drimia* sensu lato and *Urginea* to be recognized as a genus on its own. The genus *Sypharissa* of Salisbury (1866) was not taken up by other systematists. Steinheil (1834) had established the genus *Urginea*, which consisted of two groups of species, one from the Mediterranean Region with four species and the other from the Cape Winter-rainfall Region with three species. The generic name *Urginea* was derived from Ben Urgan, the name of an Arab tribe. Steinheil illustrated the common species from Algiers, *U. fugax* (Moris) Steinheil, which has been selected as the lectotype.

The three Cape species placed by Steinheil under *Urginea* were illustrated and named by Jacquin in 1794-1795 as *Anthericum filifolium*, *A. exuviatum* and *A. fragrans*. Their flowers resemble those of *Anthericum*, such as *A. bipedunculatum* Jacq. [now *Chlorophytum triflorum* (Ait.) Kunth], which led Jacquin to place them in this genus. Subsequent systematists, however, aware of the fact that the underground parts were bulbous, not rhizomatous, removed them from *Anthericum* to *Albuca* (Ker-Gawler, 1805) to *Urginea* (Steinheil, 1834) and to *Ornithogalum* (Kunth, 1843). Eventually Salisbury (1866) placed them in a new genus, *Sypharissa*, the name being a reference to the striate, membranous, sheathing cataphylls, which reminded him of the slough of a snake. Baker in 1873 returned them to *Urginea* as the tribe *Sypharissa*.

A close examination of the three species illustrated by Jacquin, and one other recently described, all from the Winter-rainfall Region, revealed a number of differences with *Urginea* Steinheil s.s. and *Drimia* Jacq. The bulb is of the *Tulipa*-type, whereas that of *Drimia*

and *Urginea* is of the *Narcissus*-type. The shoot, consisting of synanthous deciduous leaves and a raceme, is surrounded by long, sheathing cataphylls which form very characteristic membranous apices that are markedly striate with raised dark transverse ridges. The leaves and racemes are deciduous while the bases of the cataphylls become swollen to form the bulb-scales. (In the *Narcissus*-type the leaf-bases swell up to form the bulb-scales.)† Other characters shared by these three species are the stout, erect stamens with basifixed anthers surrounding the ovary and the declinate, exserted style.

SYPHARISSA

Sypharissa Salisb., Gen. Pl.: 37 (1866). Type species: *S. exuviata* (Jacq.) Salisb. ex Oberm. (lecto-type).

Anthericum sensu Jacq. partly as to *S. exuviata*, *S. filifolia* and *S. fragrans*.

Urginea Steinheil in Annls Sci. nat., sér. 2, 2: 322 (1834), partly as to South African species.

Urginea, tribe *Sypharissa* Bak. in J. Linn. Soc., Bot. 13: 216 (1873).

Drimia sensu Jessop in Jl S. Afr. Bot. 43: 269 (1977).

Bulb of the *Tulipa*-type. The young cataphylls prolonged above into cylindric membranous sheaths enveloping the new shoot, their length depending on depth of bulb; apical exposed part with raised, transverse, purple or brown ribs, becoming worn with age, lower part persisting, forming the swollen white bulb scales; caudex often woody in old bulbs and bearing long, stout roots in some species or many thinner ones. *Leaves* synanthous, deciduous, 1-∞, long, terete. *Raceme* simple, few to many-flowered; peduncle smooth, terete; lower bracts boat-shaped, from a wide base, acuminate, with a long, acute, basal spur, upper reduced, their spurs rudimentary. *Flowers* diurnal, open for part of the day, flowering for several days, sweetly scented. *Perianth* stellate, the 6 tepals spreading, usually white with a dark, reddish brown or green midrib. *Stamens* 6, erect, surrounding ovary, filaments firm, anthers basifixed, opening by longitudinal slits. *Ovary* 3-locular, oblong-globose with many biseriate axile ovules; style terete, exserted (at least when receptive) declinate; stigma globose, papillate. *Capsule* 3-locular, the valves with thickened margins; seeds oval, flat, with a loose dark shiny testa.

A genus of 4 species found in the Cape Winter-rainfall Region, east as far as Port Elizabeth and west as far as southern South West Africa. Flowering September-December.

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† Three species of *Ornithogalum*, namely *O. anguinum* Leight. ex Oberm., *O. monophyllum* Bak. (section *Urophyllo*) and *O. zebrium* Bak. ex Oberm. (section *Osmyne*) appear to possess the *Tulipa*-type of bulb as well. They, too, form transversely striate cataphylls enveloping leaf and peduncle. The genus *Gethyllis* in the Amaryllidaceae also possesses the *Tulipa*-type of bulb, with well-developed cataphylls.

Key to species

Leaves c. 4, coriaceous, linear, semi-circular or grooved, 3–4 mm in diam., glaucous-green; seed oval, c. 8 mm long; coarse plants with thick, long roots; raceme about as long as leaves or shorter . . . 1. *S. exuviata*
 Leaves many (1–few in juvenile plants), soft, 0.5–2 mm in diam., green; seeds 3–6 mm long; plants more slender; roots various; raceme as long as leaves or exserted:

Leaves c. 1–1.5 mm in diam.:

Raceme many-flowered, elongated, exserted above the bunch of leaves; roots thick, long, woody; seeds c. 6 mm long. 2. *S. fragrans*

Raceme about as long as leaves; flowers usually close together, shortly racemose to subcorymbose (in juvenile plants); seeds c. 4 mm long. 3. *S. filifolia*

Leaves c. 0.5 mm in diam., filiform, very many. 4. *S. multifolia*

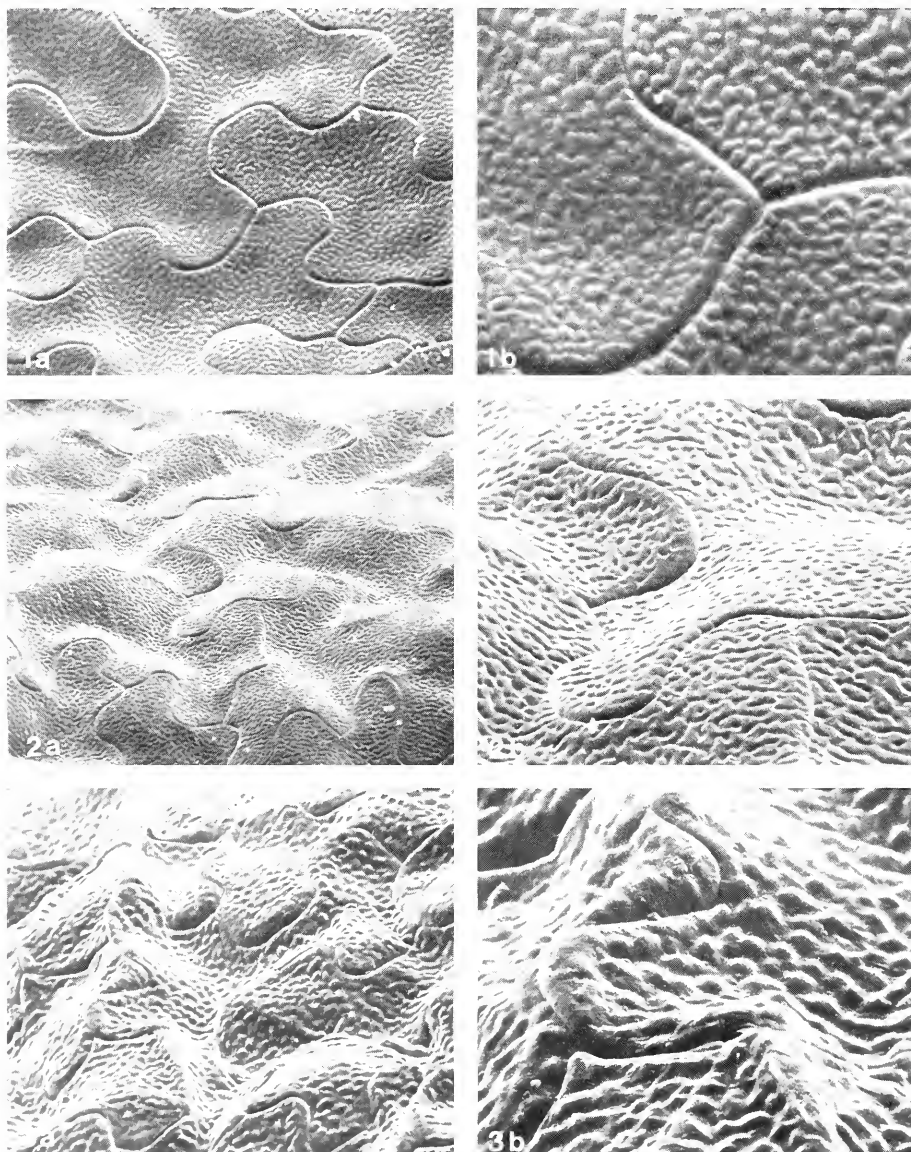


FIG. 1.—SEM photographs of testa of *Sypharissa* seeds. 1, *S. exuviata*: a, $\times 700$; b, $\times 2\,000$.
 2, *S. fragrans*: a, $\times 700$; b, $\times 2\,000$ 3, *S. filifolia*: a, $\times 700$; b, $\times 2\,000$.

1. *Sypharissa exuviata* (Jacq.) Salisb. ex Oberm. comb. nov.* Iconotype: Cape, Jacq., Icon. Pl. Rar. 2 (13), t. 415 (1794).

Anthericum exuviatum Jacq., Coll. Suppl. 89, t. 14, fig. 2 (1797), Icon. Pl. Rar. l.c.: Willd., Sp. Pl. 2: 136 (1799). *Phalangium exuviatum* (Jacq.) Poir., Encyc. 5: 243 (1804). *Albucca exuviata* (Jacq.) Ker-Gawl. in Curtis's bot. Mag. 22: t. 871 (1805). *Urginea exuviata* (Jacq.) Steinh. in Annl. Sci. nat. sér. 2, 2: 330 (1834); Bak. in Fl. Cap. 6: 466 (1897); Duthie in Ann. Univ. Stell. 4, A, 2: 6 (1928); Adamson in Adamson & Salter, Fl. Cape Penins. 193 (1950). *Ornithogalum exuviatum* (Jacq.) Kunth, Enum. Pl. 4: 369 (1843). *Drimia exuviata* (Jacq.) Jessop in JI S. Afr. Bot. 43: 276 (1977).

Coarse plants up to 1 m tall. *Bulb* ovoid with loose, broad, fleshy scales, the inner extended above into cross-barred, purplish, membranous sheaths up to 150 mm long; caudex elongated in older bulbs, hard, bearing many thick, long roots. *Leaves* 1–5, suberect or sprawling, semicircular becoming grooved when dry, up to 1 m long, 3 mm broad, leathery, glaucous. *Raceme* about as long as leaves or shorter, many-flowered; peduncle erect, stout in fruit; bracts long-caudate in lowest flowers, upper reduced; pedicels c. 10 mm long, up to 15 mm in fruit. *Flowers* typical; tepals up to 15 mm long and 5 mm broad. *Capsule* oblong-ovoid, 15–25 mm long; seeds typical, c. 10 mm in diam. Fig. 1.1.

Recorded from the Cape Winter-rainfall Region, from Namaqualand to Port Elizabeth and Grahamstown in sandy, peaty habitats or in humus-rich rock crevices, often locally frequent; flowering in September–October, but according to Adamson, only after fires.

CAPE.—2917 (Springbok): Steinkopf (–BD), Meyer sub *Marloth* 13320 (PRE). 3119 (Calvinia): Klipkoppie, Nieuwoudtville (–AC), Barker 9763 (NBG). 3317 (Saldanha): Kreeftebaai (–BB), Rourke 587. 3318 (Cape Town): Malmesbury Commonage (–BC), Lewis 3621: Stellenbosch Flats (–DD), Duthie 1750; Camps Bay (–CD), Zeyher 4655 (SAM). 3325 (Port Elizabeth): Zwartkops River, Zeyher 105b (SAM). 3326 (Grahamstown): Bushman's River Bridge (–CB), Archibald 5314 (PRE). 3419 (Caledon): Rivierzondereinde (–AB), Zeyher 4248 (SAM). 3421 (Riversdale): 16 km S. of Albertinia (–BA), Acocks 22883.

2. *Sypharissa fragrans* (Jacq.) Salisb. ex Oberm. comb. nov. Type: Jacq., Hort. Schoenbr. 1, t. 86.

Anthericum fragrans Jacq., Hort. Schoenbr. 1, t. 86 (1797). Willd. Sp. Pl. 2: 135. *Phalangium fragrans* (Jacq.) Poir., Encycl. 5: 247 (1804). *Albucca fugax* Ker-Gawl. in Bot. Register 4: t. 311 (1818), nom. nov. for *Anthericum fragrans* Jacq. (not to be confused with *Urginea fugax* Steinh.). *Urginea fragrans* (Jacq.) Steinh. in Annl. Sci. nat. sér. 2, 2: 328 (1834); Bak. in Fl. Cap. 6: 465 (1897). *Ornithogalum fragrans* (Jacq.) Kunth, Enum. Pl. 4: 366 (1843).

Drimia exuviata sensu Jessop in JI S. Afr. Bot. 43: 276 (1977).

Plants usually found in groups. *Bulb* forming a long, woody caudex bearing long, thick, hard roots, the outer scales remaining fairly loose and soft; young inner tunics forming a short to long, white, membranous sheath (its length depending on depth of bulb) the upper part exerted, with an acute purple fluted apex. *Leaves* c. 20, terete, erect or somewhat flexuose, c. 300 mm long, soft. *Raceme* exerted above bundle of leaves, c. 40-flowered, elongating with age; peduncle firm, becoming woody in fruit. *Flowers* typical; tepals c. 10 mm long. *Capsule* narrowly oblong, 16 mm long, valves fairly thin; seed oblong, 8 mm, typical. Figs 1.2 & 2.

Recorded from Malmesbury to Calvinia, in sandy areas, locally abundant, in colonies; flowering September to November.

* Since Salisbury did not validly publish the combination, this is done here.



FIG. 2—*Sypharissa fragrans*. Raceme, $\times 2$, Hanekom 2086.

CAPE.—3118 (Vanrhynsdorp): summit of Gifberg (–DA), Hall 3906; Klawer (–DC), Godfrey VH-1254. 3119 (Calvinia): Lokenburg (–CA), Acocks 18572. 3218 (Clanwilliam): Het Kruis (–DA), Barker 2597. 3219 (Wuppertal): Citrusdal, Thee Rivier (–CC), Hanekom 2086. 3318 (Cape Town): near Hopefield (–AB), Letty 38. 3319 (Worcester): Saron (–AA), Herre in STE 26768.

This is the tallest species in the genus; it is many-flowered, attractive and strongly scented.

3. *Sypharissa filifolia* (Jacq.) Salisb. ex Oberm. comb. nov. Iconotype: Cape, Jacq., Icon. Pl. Rar. 2(15): t. 414 (1794).

Anthericum filifolium Jacq., Coll. Suppl. 93 (1797), Icon. Pl. Rar. 2 (15): 18, t. 414 (1794); Willd., Sp. Pl. 2: 135 (1799). *Phalangium filifolium* (Jacq.) Poir., Encycl. 5: 242 (1804). *Albucca filifolia* (Jacq.) Ker-Gawl. in Bot. Register 7: 557 (1821). *Urginea filifolia* (Jacq.) Steinh. in Annl. Sci. nat. sér. 2, 2: 329 (1834); Bak. in Fl. Cap. 6: 466 (1897); Duthie in Ann. Univ. Stell. 6A (2): 6 (1928); Adamson in Adamson & Salter, Fl. Cape Penins. 193 (1950). *Ornithogalum filifolium* (Jacq.) Kunth, Enum. Pl. 4: 369 (1843).

Anthericum spiratum Thunb., Prodr. 62 (1794). Syntypes: "Cap. b. spei", Thunberg s.n. (UPS—8413, 8414, microfiche!).

Urginea unifolia Duthie in Ann. Univ. Stell. 6A (2): 8–9 (1928); Adamson in Adamson & Salter, Fl. Cape Penins. 193 (1950). Type: Cape, Stellenbosch Flats, Duthie in STE 1891 (STE, holo.!).

Urginea duthieae Adamson in JI S. Afr. Bot. 8: 239 (1942) sine descr. latine and in Fl. Cape Penins. 194 (1950). Type: Cape, Stellenbosch Flats, Duthie in STE 1790 (STE, holo.!). K, nom. nov. for *Urginea ecklonii* sensu Duthie in Ann. Univ. Stell. 6A (2): 6 (1928) non Bak. *Drimia duthieae* (Adamson) Jessop in JI S. Afr. Bot. 43: 278 (1977).

Urginea flexuosa Adamson in JI S. Afr. Bot. 8: 240–241 (1942), Fl. Cape Penins. 193 (1950). Type: Cape Peninsula, Smitswinkel Bay, Adamson 3099 (BOL, holo.!).

Drimia exuviata sensu Jessop in JI S. Afr. Bot. 43: 276 (1977), non Jacq.

Plants 100–300 mm tall. *Bulb* ovoid, c. 30–40 mm in diam. compact, often enclosing 2–3 daughter bulbs, or outer scales disintegrating and scales then

spreading (in juvenile plants the small bulbs consist of c. 4–6 rounded succulent opposing scales); cataphylls membranous, soon disintegrating; roots many, swollen during active growth. *Leaves* numerous, slender, filiform, glabrous, straight or laxly flexuose, up to 280 mm long and c. 1 mm in diam. (in juvenile plants with 1–3 leaves). *Inflorescence* racemose, about as long as leaves, 6–30-flowered (in juvenile plants the few flowers often congested to subcorymbose); peduncle terete; bracts of lowest flowers bearing a long sharp spur which is reduced in upper. *Perianth* with tepals 8–12 mm long, white or flushed with purple and with a dark midrib. *Stamens* typical. *Ovary* green; style white or purplish, declinate. *Capsule* oblong-globose, coriaceous, c. 10 mm long, brown; seeds numerous, ovate, 2–3 mm wide with a loose wide membranous wing, shiny black. Fig. 1.3.

Frequent on the Cape Peninsula to Vanrhynsdorp and east to Bredasdorp, in sandy or gravelly soil, locally common as scattered plants, flowering September to December. Adamson records it as flowering frequently after fires.

CAPE.—3118, (Vanrhynsdorp): S. of Vredendal (–DA), *Acocks* 19713/3119 (Calvinia): Lokenburg (–CA), *Acocks* 17264. 3219 (Wuppertal): Citrusdal (–CA), *Barker* 7395. 3318 (Cape Town): Camps Bay (–CD), *Zeyher* 134; Stellenbosch Flats (–DD), *Duthie* in *STE* 652; *Taylor* 5147. 3319 (Worcester): Visgat–Agterwittenberg (–AA), *Emdon* 254; Tulbagh (–AA), *Barker* 9230. 3320 (Montagu): Poort N. of Pienaarskloof (–AA), *Acocks* 23709. 3418 (Simonstown): Bergvliet Farm (–AB), *Purcell* s.n. 3420 (Bredasdorp): 16 km SE of Buffelsjagtsrivier (–BA), *Acocks* 24268.

The SEM photos of the testa of the seeds of *S. filifolia* and *Urginea unifolium* Duthie revealed that they belong to one species. This was confirmed by a transverse section of the leaf. Duthie (1926) in her informative study of the *Urginea* species of the Stellenbosch Flats on Plate 4, figs 3, 5, 7 and 9, drew sections of the leaves of *U. exuviatum* and *U. filifolium*. It was seen that the transverse section of the leaf of *U. unifolium* was similar to that of *S. filifolia*. The testa of the seed of *U. duthieae* (SEM, $\times 700$, $\times 1\,000$) matched that of *Sypharissa filifolia*.

There is a problem about the dates of *Anthericum filifolium* Jacq. and *A. filifolium* Thunb., Prodr. 62, two different species which were both published in 1794. However, Roemer & Schultes (1829), and later Kunth (1843), accepted that Jacquin's name was older and Thunberg's plant was renamed *Anthericum nematodes* Roem. & Schl. (= *Urginea nematodes* Bak.) and *Ornithogalum thunbergii* Kunth.

4. *Sypharissa multifolia* (Lewis) Oberm. comb. nov.
Type: W. Cape, 42 km S. of Springbok. Lewis 2302 (SAM, holo.!).

Urginea multifolia Lewis in Ann. S. Afr. Mus. 40: 9 (1952).
Drimia multifolia (Lewis) Jessop in Jl S. Afr. Bot. 43: 278 (1977).

Bulb globose, c. 450 mm in diam. with pallid scales, often dividing and forming small clumps; roots thick; shoot surrounded by 1–several elongated, membranous, fluted, sheathing scales. *Leaves* very numerous (30–50), filiform, thin, up to 100 mm long, 0.5 mm broad, forming loose spirals. *Raceme* up to 250 mm long, exserted, firm about 30-flowered; lower bracts spurred; pedicels patent-erect, up to 8 mm long, thin. *Flowers* typical, with sweet scent (resembling that of *Lippia citriodora* fide Lewis). Capsule and seeds unknown.

Apparently rare in S.W. Cape and Namaqualand; on dolerite ridges.

CAPE.—2917 (Springbok): 42 km S. of Springbok (–DD), *Barker* 6310. 3017 (Hondeklip Bay): Kamieskroon (l'Aus), *Schlechter* 11222. 3119 (Calvinia): Kareekom, 40 km N.W. of Calvinia (–AB), *Leistner* 477.

UNCERTAIN SPECIES

A collection from South West Africa, *Giess* 12857 from farm Kubub, LU 15, sandy flats (2616 CB), is too incomplete for positive identification.

UITTREKSEL

Die genus Sypharissa Salisb. (Liliaceae) is weer erken en die vier soorte wat daaronder val is wettig gepubliseer.

REFERENCES

- ADAMSON, R. S. & SALTER, T. M., 1950. *Flora of the Cape Peninsula*. Cape Town: Juta.
BAKER, J. G., 1873. Revision of the genera and species of Scilleae and Chlorogalae. *J. Linn. Soc., Bot.* 13: 209–292.
JACQUIN, N. J., 1786–97. *Collectanea*. Vienna: Kraussiana.
JESSOP, J. P., 1977. Studies in the Bulbous Liliaceae in South Africa: 7. *Jl S. Afr. Bot.* 43: 265–319.
KER-GAWLER, J. B., 1805. *Albuca exuviata*. *Curtis's bot. Mag.* 22: t. 871.
KER-GAWLER, J. B., 1821. *Albuca filifolia*. *Bot. Register* 7: t. 557.
KUNTH, C. S., 1843. *Enum. Pl.* 4. Stuttgart & Tübingen: Cottae.
POIRET, J. L. M., 1804. *Phalangium*. In Lamarck & Poiret, *Encyclopédie méthodique botanique* 5. Paris.
SALISBURY, R. A., 1866. *The genera of plants*. London: Van Voorst.
STEARNS, W. T., 1978. Mediterranean and Indian species of *Drimia* (Liliaceae): a nomenclatural survey with special reference to the medicinal squill, *D. maritima* (syn. *Urginea maritima*). *Ann. Musei Goulandris* 4: 199–210.
STEINHEIL, A., 1834. *Urginea*. *Annls Sci. nat. Bot. Sér.* 2, 321–330.
THUNBERG, C. P., 1794–1800. *Prodromus plantarum Capensium*. Uppsala: J. F. Edman.

Some observations on two early Cape florilegia

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ABSTRACT

A number of early Cape florilegia and codices exist in libraries in Europe and South Africa. Four of these florilegia are closely related and are housed in the Brenthurst Library, Johannesburg, the Botanical Research Institute, Pretoria, the Bodleian Library, Oxford and the Rijksherbarium, Leiden. The first two are compared and discussed in detail in this article. Arising from this comparison, a new interpretation of the interrelationship and origins of the four florilegia is proposed. The key volume is the florilegium in the Botanical Research Institute, Pretoria.

RÉSUMÉ

CERTAINES OBSERVATIONS SUR DEUX ANCIENS FLORILEGIA DU CAP

Un certain nombre d'anciens florilegia et codices du Cap se trouvent dans les bibliothèques d'Europe et d'Afrique du Sud. Quatre de ces florilegia sont étroitement apparentés et se trouvent à la bibliothèque Brenthurst de Johannesburg, à l'Institut de Recherche Botanique de Pretoria, à la Bodleian Library d'Oxford et au Rijksherbarium de Leiden. Les deux premiers sont comparés et discutés en détails dans cet article. Émergeant de cette comparaison, une nouvelle interprétation de l'inter-relation et des origines des quatre florilegia est proposée. Le volume clef est le florilegium de l'Institut de Recherche Botanique de Pretoria.

INTRODUCTION

The Cape flora has for three centuries excited the interest of botanists. With the remarkable increase in the exploration of the world from the fifteenth century, new areas with fascinating plants and animals became known to the educated and knowledge-hungry world of Europe. The Cape of Good Hope became a vital stopping-over point for the many ships going to the East in search of spices and riches. It was thus inevitable that plants growing at the Cape found their way back to Europe. Soon the demand for these unusual plants, both to grow and to possess as dried specimens or paintings, increased considerably.

During the governorship of Simon van der Stel from 1679 to 1699, there began a period of considerable exploration and expansion. This was accompanied by a significant increase in the scientific knowledge of the indigenous flora and fauna with Van der Stel himself as the worthy patron. It is known that he commissioned the artist Claudius to record by means of sketches the natural history of the area and also the gardeners, Oldenland and later Hartog, to build up "one of the most beautiful and curious gardens I have ever seen" (Tachard, 1686).

Illustrated books on the Cape flora were not available at the time and so collections of paintings, florilegia or codices of animals were also included, were produced for influential patrons of natural history. Among these florilegia or codices were the Codex Witsenii, Codex Bentingiana, Codex Comptoniana, Dolneus's Florilegium, Van der Stel's own Collection and the Codex accompanying the official report of his Expedition to Namaqualand in 1685/6. Gunn & Codd (1980) give a fine overview of early Cape botanical history in which they discuss these works and their significance.

Examples of early Cape florilegia and codices exist today in various institutes and libraries in Europe and South Africa, namely:

Botanical Research Institute, Pretoria (BRI)	Brenthurst Library, Johannesburg (BFC)
Rijksherbarium, Leiden (LD)	Bodleian Library, Oxford (OXF)

South African Museum, Cape Town (SAM)
Africana Museum, Johannesburg (IPA)
British Museum (Nat. Hist.), London (BM)

South African Public Library, Cape Town (SAPL)
Trinity College, Dublin (TCD)

The works mentioned in this paper will be referred to by the abbreviations given above for the institutes and libraries where they are housed. Much has been published about these works by Waterhouse (1932) Barnard (1947), Smith (1952), Jessop (1965), Edwards (1965), Kennedy (1967), Macnae & Davidson (1969), Gunn & Du Plessis (1978), Waterhouse (1979) and Gunn & Codd (1980).

The florilegia in the first four institutes mentioned above are of particular interest to me because of their close relationship, one of them being in the library of the Botanical Research Institute, Pretoria. Jessop (1965) published a detailed account of this florilegium, but unfortunately at the time did not know of the existence of the other three florilegia. Gunn & Du Plessis (1978) edited and wrote the introduction to the so-called Flora Capensis of Jakob and Johann Philipp Breynia, housed in the Brenthurst Library and which was reproduced *in toto* by the Brenthurst Press, Johannesburg. They were unable to give a detailed comparison of the four florilegia. Resulting from my close examination of BFC and BRI while writing a review of the BFC reproduction for Bothalia (Oliver, 1980), I have been able to extend the published notes and observations on the two florilegia in South Africa. I have not had the opportunity to examine the florilegia in Oxford and Leiden and accept the statements made by Gunn & Du Plessis (1978), who have consulted them. In the discussions which follow, reference is made to the numbering of the plates (as arranged by Gunn & Du Plessis) in the Brenthurst reproduction of the Breynia's Flora Capensis

BINDING

The most noticeable difference between BFC and BRI is in the size of the volumes, where the page size in BFC is 310 × 195 mm and in BRI 393 × 250 mm. This difference in size is significant as will be seen when the origins of the two florilegia are discussed later on. The Brenthurst reproduction of BFC has

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been reduced to an even smaller size, the title page being 230 mm long instead of 270 mm (Gunn & Du Plessis, 1978). Reference to the list of plates at the beginning of BFC shows that 47 of the 102 paintings had to be reduced.

The binding of BFC is full red morocco leather with gold tooling including the Breynes's coat-of-arms. The pages have been gilded. On the title page it is stated that the volume was bound by the younger Breyne in 1724. BRI on the other hand is plainly bound in vellum, much like the codices SAM and SAPL; the tooling is blind and the edges of the pages have been spattered with red and blue ink. On the front cover there is a distinct erect capital P done in slightly faded black ink. Barnard (1947) mentions a capital Q on the front cover of SAM. I examined SAM and find that the Q slants obliquely to the right, is smaller and is placed at the top of the front cover.

Gunn & Du Plessis mention the binding of the pages of BFC, but give no details about the gatherings. It was not possible for me to ascertain the exact binding sequence as the original book had recently been restored. They do, however, mention that forty-nine leaves have no fold-marks and forty-nine have fold-marks which indicate that these folded leaves were painted on at the Cape, folded and then despatched to Europe. They also mention the extra pieces of paper which had been glued into these folded leaves, when binding took place, in order to bring all the pages up to the same size. Some of the paintings on the larger sheets had in turn been cut during binding. This is most noticeable on the coloured frontispiece and plates BFC 30 and 42.

BRI is bound into gatherings of 5 or 6 sheets with one gathering of 7 sheets. These sheets are folded giving gatherings of 10, 11, 12 or 13 pages with three instances of single pages having been tipped in during binding. Jessop (1965) points out that the same cutting of paintings occurred in BRI and feels that the paintings must have been executed before the book was bound. The cut paintings occur only on BRI 8, 68, 86 and 109 to any extent, but far less than in BFC. One's interpretation of the term "binding" is, to my mind, important. I feel that the book was made up with a softish cover, as is found in SAPL, to form a working volume into which the paintings could be executed. At a later stage the volume was slightly trimmed when the soft cover was replaced by a proper vellum binding for placing in some person's library. The 68 blank pages at the end of BRI give a very strong indication that the water-colours were painted into the book. Another point which supports this view is the statement by Tachard (1686) that Claudius "had already completed two thick volumes of divers plants, painted from nature".

The other florilegia in South Africa are rather similar to BRI in appearance. IPA is most like BRI being similar in size and vellum binding. The paper is of the same thick quality and the paintings are done on the recto of each page with binding in gatherings. In SAM and SAPL the volumes are much smaller, like BFC. In these two florilegia the binding of the sheets is interesting. The leaves are folded double and bound singly giving a lot of 2-paged gatherings. The paintings occur on the recto of the first page with the descriptions on the verso in SAM and the recto of the second page in SAPL.

Both Gunn & Du Plessis and Jessop give details of the watermarks found in the respective florilegia and discuss the possible origin and date of manufacture of the paper. In BFC there is a number of different types of paper. Gunn & Du Plessis did not, however, mention the connection between watermarks and countermarks presumably due to the difficulty of unravelling the binding sequence of so many varied sheets. They do mention the similarity of the watermarks in BFC, SAM and TCD. BRI, on the other hand, has very uniform paper of only two types. Jessop gives an illustration of the main watermark, the Strassburg lily with coronet, mantling and 4WR and the main countermark, IHS/DYSVLI (cf. left-hand pair, Fig. 1 in the present article). He noted that a few pages possessed a different countermark, IHS/RM. This is, in fact, the countermark for a slightly different watermark which is more crudely produced and of smaller size (cf. right-hand pair, Fig. 1). The countermark itself is very much cruder, as well, and this suggests either an inexperienced papermaker or paper of earlier origin before the refinement of the watermarking technique. This cruder watermark occurs in paper that takes up two bound gatherings of 22 pages between paintings 111 and 132.

The main watermark occurs a number of times in IPA, but with different countermarks. It also occurs in the Claudius animal paintings in the Africana Museum in Johannesburg, as figured by Smith (1952). It can also be seen in the binding paper of Commelin's *Horti Medici Amstelodamensis* (1697–1701) and in the body of the book where different mantling and the countermark of Pieter van der Ley occur. Both the main watermark and countermark of BRI occur once in BFC.

Churchill (1935) states that the Strassburg Lily with 4WR was first used in 1636 and is of German origin. Jaffe (1930) and Heawood (1950) say it was made at the papermill of one Wendelin Richel (Riehel), which began production in 1583 without countermarks. This watermark became associated with quality paper and was much copied in Europe. Jaffe also states that the countermark, IHS surmounted by a cross, "*In Hoc Signo*", was first used in the Lombardy area in Italy from 1481–1580 before being taken up in the Lothringen area of Germany. The version with DYSVLI was one of the many countermarks used by J. Villedary (Vildary) whose mills produced paper over a period of 150 years from 1658–1812. The countermark with RM is unknown, but noted by Heawood (1950).

It is not possible, using currently available references, to put any date to the manufacture of the paper in BRI. Jessop (1965) feels that the paper was made in about 1700. Gunn & Du Plessis (1978), however, were able to use the BFC watermarks and countermarks more usefully and they dated most of the BFC paper to the last half of the 1600's. This led them to the assumption that BFC was the oldest volume in the series of four similar florilegia. A more exact date can be deduced by reference to certain statements made by J. P. Breyné and Seyler in the *Prodromi* of 1738. Jakob Breyné was said to have left his collection of paintings, later bound into the volume BFC, to his son on his death in 1697. Therefore, if no additions were made by the son, one can deduce that the paintings must have been executed before 1697. Jakob Breyné had in 1678 produced his *Centuria* containing among the 100 plants, illustrations of 48 Cape species, including

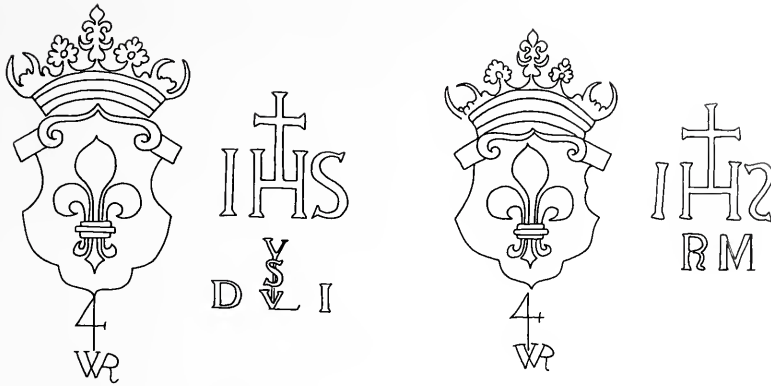


FIG. 1.—Watermarks and countermarks in the paper in the BRI forilegium, $\times 0.5$.

Erica cerinthoides, but did not use any BFC paintings for these plates. Thus it can be assumed that he did not possess any BFC paintings at the time. This means that he must have received the paintings from the Cape between 1678 and his death early in 1697.

THE PAINTINGS

The BFC volume contains water-colour paintings of 102 species of which 66 occur in BRI and 36 are exclusive to BFC. Included in the last set are two paintings which are known to have occurred in BRI, but are now missing (see under Numbering). Gunn & Du Plessis (1978) recognized two different qualities of art-work and grouped the paintings into Group A of superior quality and Group B of poorer quality. They ascribe 37 paintings to Group A and 65 to Group B. I would, however, have placed the two non Cape paintings, BFC 60 and 69, in Group A. I would also regard BFC 18, *Spiloxene alba*, as being a Group A painting and BFC 42, *Chasmanthe aethiopica*, as Group B. This leaves all the 36 Cape species exclusive to BFC belonging to the Group B painting quality. I have followed the same arrangement of groups for convenience in this comparison.

The BRI volume contains water-colour paintings of 148 species of which there are the 66 shared with BFC and 82 exclusive to BRI. In my opinion the 148 paintings can be divided into 115 being Group A and 27 being Group B with 6 paintings being impossible to place with certainty. All of the 82 paintings exclusive to BRI are of Group A quality. The Group A paintings, however, can be subdivided into a possible two or even three different styles. The majority matches the Group A style paintings in BFC. At the beginning of BRI there is a series of paintings, namely 3, 5, 6, 7, 8, 9, 10, 17, 18, 19 and 20, which are in a completely different style, rather vague and lacking precise details and yet not crude like some of the Group B paintings. These paintings are undoubtedly the work of a different artist and strike me as being originals. Their quality and colours remind me of the work of the "second artist" in IPA.

Most of the Group A paintings are accurate and beautifully executed. Towards the end of the series of paintings the quality of the paint seems to change, the greens being much deeper in colour with a bluer tinge and the paint is much thicker. These paintings could also be the work of another artist. One painting, BRI 135, stands out as completely different from the rest of the numbered plates. It is of *Crassula coccinea*

and is classified as a Group B painting, but gives the strong impression of having been executed in the Claudius style like the paintings occurring in SAM and SAPL. The paint is of quite a different texture and the painting lacks any perspective. The extra painting of *Erica cerinthoides*, an unnumbered one occurring with BRI 132, is mentioned by Jessop as also unlike any others in style and quality of paint. This paint is very reminiscent of the powdery type used in the Group A paintings in BFC as it is smudging slightly and has left an imprint on the recto of the preceding page. This feature also occurs on BRI 99 in the browns of the rather large tuber of the *Bulbine tuberosa*.

The differences between the Group A and Group B paintings in BRI are very marked, particularly where the two styles occur on the same page, e.g. BRI 55, *Lobelia pinifolia* (A) and 56, *Drosera cistiflora* (B); BRI 71, *Pelargonium longifolium* (A) and 72 *Moraea tricuspidata* (B); BRI 75, *Mesembryanthemaceae* (A) and 76, *Galaxia ovata* (B) and 77, *Dorotheanthus bellidiformis* (B). In these examples it is always the Group A painting which is on the left-hand side of the page and numbered first. This would indicate that the small Group A painting was done first leaving space on the page for additional species to be illustrated at a later stage which, in the above cases, turned out to be rather crude Group B paintings. This feature of the two distinct qualities of paintings on the same page is important in respect to the problem of the origin of these florilegia.

Gunn & Du Plessis (1978) are of the opinion that the paintings of BFC are the originals in the set of four very similar florilegia. They based their opinion on the dating of the paper—"The paper used in the Breynes's 'Flora Capensis' is the earliest and of a period consistent with the possibility that it is the original set". This might be true of the paper, but not of the paintings, as the following points obtained from a detailed comparison of BFC and BRI will show. Gunn & Du Plessis (1978) state that the volumes in Oxford and Leiden are obviously inferior copies, which opinion I must accept not having had the opportunity to examine them myself.

The most noticeable difference between the BFC and BRI paintings in the Group A series is the shortened dimensions of many of the paintings in BFC. The floral parts of the paintings are painted the same size as those in BRI, but the vegetative parts, particularly the stems, have been reduced to be

able to fit onto the smaller size of the BFC paper, in some cases so drastically as to make the painting disproportionate. Good examples of this feature may be seen when comparisons are made of BFC 19 and BRI 125, *Spiloxene capensis*; BFC 20 and BRI 126, *Moraea aristata*; BFC 40 and BRI 109, *Gladiolus maculatus* and BFC 38 and BRI 68, *Gladiolus carneus*. The last example is illustrated in Fig. 2 where a glance will show the more natural proportions of the BRI painting. This feature would indicate that the BRI paintings could not have been copies from BFC and that the reverse is the case.

Fig. 2 also illustrates another important feature, namely the lack in BFC of certain details present in BRI paintings. In the BRI paintings of *Gladiolus carneus* there are an additional flower bud, terminal bracts and a leaf. There is also another very important and significant feature about this BFC painting, and that is the lack of paint in the region of the ovary of the basal flower, where the artist forgot to fill in the colour. This also occurs in BFC 39, BRI 122, *Gladiolus hyalinus*. Further examples of parts of the plants being left out in the BFC paintings can be found in paintings which lack roots, hairs, flowers,



FIG. 2.—*Gladiolus carneus* Delaroche. Left, painting number 68 from the BRI florilegium, $\times 0.5$; right, painting number 38 from the BFC florilegium (Brenthurst reproduction), $\times 0.75$.

corms or branches. An additional very marked example of this feature is shown in Fig. 3, *Polygala bracteolata*.

There are, however, a few examples where this loss of details in BFC is reversed and one finds BFC paintings with more parts. An example is shown in Fig. 3, *Empodium plicatum*, where the lateral flower has many more tepals than the species should have, but this is more the result of an inaccurate copier. In some of the species of *Moraea* in Group B, the

BFC paintings have the old leaf bases included. In BFC 70, BRI 89, *Leonotis leonurus*, additional flowers and another inflorescence are depicted. All of these last examples are paintings of Group B and these I regard as copies in both florilegia, that is, copies from another set of paintings which may or may not have been the originals.

The act of copying is always fraught with the possibility of slips, misinterpretation or plain re-interpretation by the copier. This is evident in the



FIG. 3.—*Polygala bracteolata* L. Left, painting number 63 from the BRI florilegium; centre top, painting number 81 from the BFC florilegium (Brenthurst reproduction), both $\times 0.5$. *Empodium plicatum* (L.f.) Bak. Right, painting number 97 from the BRI florilegium, $\times 0.5$; centre bottom, painting number 62 from the BFC florilegium (Brenthurst reproduction), $\times 0.70$.

differences that occur between some of the BRI and BFC paintings. In copying the artist has produced extra curliness or waviness into the organs that he was copying. This is clearly seen in the leaves of *Empodium plicatum* shown in Fig. 3 and in the very stylized leaves of *Polygala bracteolata* in the same figure. Further examples of this type can be found in BFC.

As I am interested in ericas, I was particularly struck by the differences between the two similar renderings of *Erica cerinthoides*. In BRI 43 the leaves are shown in distinct whorls and are themselves depicted trigonous whereas in BFC 90 the leaves are randomly scattered and executed rather poorly and haphazardly by the single stroke of a brush. One can also see that the copier in BFC could not easily interpret the BRI flowers which must have been somewhat passé when painted.

Another interesting and important feature, which was also noted by Jessop (1965), is that there are several paintings in BRI which have faint pencil outlines still remaining on the pages. These are of additional parts of the plants which the artist must have decided not to use. Two clear examples are BRI 12, *Adenandra villosa*, and BRI 109, *Gladiolus maculatus*. This feature gives a strong indication that the paintings are originals and not copies.

The strangest anomaly found in the comparison of the paintings occurs in the paintings of *Sparaxis bulbifera*, BRI 102, BFC 32, both Group B paintings. The paintings have their lower halves reversed. Reversing of paintings is of course commonly encountered in engravings used for printing plates.

From the above comparison of the paintings it is my opinion that the Group A paintings in BRI are the originals and that the BFC paintings were all copied from BRI. An examination of the paints used lends additional weight to this view. In BRI the water-colours are of very good quality with most of the colours still unchanged. In BFC the paintings were executed with a very powdery paint which, as Gunn & Du Plessis (1978) noted, has changed colour in a number of cases, but due to its powdery nature, it is being smudged and rubbed off with time. As a result the coarseness of the paper is accentuated and clearly seen in the Brenthurst reproduction particularly on BFC 19, *Spiloxene capensis* (BRI 125).

The quality of the BRI Group A paintings, most of which are petaloid monocotyledons, is outstanding. The perspective in the flowers is extremely good and is far superior to any that I have seen in the other early florilegia. Some of the bulbs and corms have been painted in very fine detail, for example, BRI 125, *Spiloxene capensis*; BRI 132, *Homoglossum watsonium* and the leaf-base in BRI 49, *Urginea duthieae*. But many bulbs, corms and bases of plants have been done in much less detail. This seems, in my opinion, to indicate that the leaves and flowers were painted in the field with only pencil sketches of the vegetative parts followed by a completion of the colour work at a later stage, perhaps at camp in the evening or even at home.

Several persons such as Petiver, Witsen, Burman and the Breynes stated that their paintings were executed from live plants at the Cape. The demand for paintings in the late 1600's and early 1700's must have been due to the lack of colour reproductions in books and it is certain that copies of

originals were made to satisfy this demand. Here the enigma of the Codex Witsenii and Claudius paintings is the prime example. Copying, whether at the Cape or back in Europe, was common. A glance through IPA or the reproduction of the plates by Kennedy (1967) will show that the painting of a legume occurs twice with only a few pages separating them. The folded paper of the Group B paintings in BFC points to the copying having been done at the Cape.

It was suggested by Gunn & Du Plessis (1978) and by Jessop (1965) that some of the paintings could have been executed from plants cultivated in Europe. As many of the plants in BFC and BRI are geophytes they could easily have been grown in Europe at the time. However, one or two features point to a wild origin for the plants, certainly of the Group A species. These include the damage to the leaves caused by insects and other animals, and so accurately portrayed by the artist. The best example of this feature is BRI 42, BFC 35 of *Babiana tubiflora* which has its leaves almost completely chewed off by some grazing animal. As Gunn & Du Plessis (1978) point out "This is a very clear indication that the painting was made from a plant which grew wild at the Cape and not from a cultivated plant". Further examples of this type may be found in BRI 45, *Wachendorfia paniculata*; BRI 52, *Ornithogalum thyrsoides* and BRI 92, *Ixia paniculata*. Also, the natural dimensions of the vegetative parts of the plants suggest that the subject was a wild plant rather than one grown under glasshouse conditions in Europe.

In this discussion of the paintings in BFC and BRI it is worth mentioning that in BRI there are various pieces of plant debris lodged in between the pages. In the fold with BRI 131, on which the unnumbered painting of *Erica cerinthoides* occurs, there are three leaves of *Erica cerinthoides*. These leaves could either have become lodged in the fold when the species was being painted or at a later stage when the owner of the volume was perhaps comparing a specimen with the painting.

NUMBERING

The paintings in all of the four similar florilegia are numbered, according to Gunn & Du Plessis (1978). These numbers provide an important feature for comparison. The important volume is BRI. In this volume nearly all the paintings are numbered near the base of each plant in a consecutive sequence up to 142. Strangely the first painting is not actually numbered. Number 142 is followed by 10 unnumbered paintings and then the last two in the set numbered as 143 and 155. The sequence of sheets in the binding gatherings has not been interrupted. Four pages have, however, been cut out of BRI leaving gaps in the numbers, viz. BRI 13, 14 and 15; 27; 50; 90 and 91. As Gunn & Du Plessis (1978) state, comparison with BFC gives the identity of two of these missing paintings, because copies of BRI 27 and 90 occur in BFC. An additional three pages have been cut out of BRI near the end of the paintings, but, as no numbers are missing in the sequence, one may assume that these pages were removed before the numbering was done as stated by Jessop (1965). These pages may or may not have had paintings. Despite the anomalies in the numbering towards the end of the paintings here should have been a total of 155 paintings, but with the loss of seven there now remains the total of 148

The first set of numbers up to 98 is written in a very neat small writing with black ink while the numbers 99–143 are written in a different slightly larger writing and paler ink. Number 155 is written in another handwriting and number 57 in yet another. In several cases already mentioned, two completely different styles of painting occur on the same page and also on the same sheet of paper but separated due to the binding. These are all numbered in the sequence. Why there are two different main handwritings in the numbering and who did them cannot be answered. The numbers might have been done by the artists. Why there is the batch of 10 unnumbered paintings near the end is also a mystery. The fact that the paintings were numbered consecutively regardless of the painting styles shows that the numbering must have been done directly into the volume and must therefore be a series exclusive to BRI.

BFC has 85 pages numbered consecutively from 2–86. These numbers have been written all in the same handwriting in the top right-hand corner of the recto of each page. These numbers refer to the pages and not the paintings as on 14 pages there are two, three or four paintings. Gunn & Du Plessis (1978) give references to these 'Folio' numbers. In BFC there are 35 paintings bearing numbers near the base of the plant depicted and these numbers are the same as those on the BRI paintings of the same species. All the paintings bearing these numbers in BFC belong to the superior Group A, while all the Group B paintings in BFC are unnumbered (cf. Fig. 2).

Gunn & Du Plessis (1978) miss the real significance of this very important point which gives additional proof that the BFC Group A paintings must have been copied from BRI. None of the 31 paintings in BFC belonging to Group B and shared with BRI is numbered. This suggests that the BFC Group B paintings were copied from some originals in another volume without any numbering and that the Group A paintings were later copied from BRI together with the noting of the BRI numbers.

Two paintings with numbers stand out as unusual. BRI 63, *Polygala bracteolata*, a Group A painting, occurs in BFC as a Group B painting (cf. Fig. 3). If the copying of the Group A paintings had been so good why had this species been copied so poorly. The other unusual painting is BFC 13, *Hessea cinnamomea*, Group A. In BFC it bears the number distinctly written as 105, but BRI 105 is of a Group B leguminous species. *H. cinnamomea* in BRI is 108, but the 8 is rather indistinctly written and at a glance could well be mistaken for a 5 which is most probably what the copier did.

Gunn & Du Plessis (1978) state that the two volumes in this series of four similar florilegia, OXF and LD, both contain paintings they regard as inferiorly executed copies. They state that "The numbers at the base of all the paintings . . . are in the first instance related to this volume 'BFC' where the numbers appear chronologically and related to page numbers". The OXF volume is vellum-bound and has the paintings pasted onto the page and signed "A.B. del". They mention that one of the younger Breyn's daughters had signed her own paintings "A.B.". However, Edwards (1964) states that this volume forms SHERARD MS. 188 and is a collection of paintings no doubt drawn by Anthonie van Breda, of plants growing in gardens in Holland. Boerhaave bought the volume for Sherard from Levinus Vincent who through marriage acquired van Breda's famous museum. This relationship of the

volume with van Breda and its very strong similarity with BRI and BFC is very confusing and needs further investigation.

The LD "volume" is in fact a set of loose paintings of inferior quality which were acquired by D. van Rooyen at two auctions in 1778 and 1779. Gunn & Du Plessis (1978) suggest a possible link between some of these paintings and the collections of Seba.

There occurs in the BRI volume with the numbering on only 17 paintings in the first 96, a plus sign. In some cases this plus sign looks as though it was done by the numberer, in others by Burman (cf. Fig. 4). All of the 17 paintings belong to Group A. The significance of this sign is as yet not understood.

COMMON NAMES

BFC and BRI have a number of paintings accompanied by a common name in Dutch (cf. Fig. 3) or occasionally a Latin polynomial. They are all written in the same, but very different, handwriting in each volume. These common names were given to nearly all of the Group B paintings but a few were given in BRI to Group A paintings by the same person (cf. Fig. 4, left). In BRI, 27 paintings have common names, 23 Group B, 4 Group A with the remainder of Group A without a common name. BFC has the same 27 paintings with common names except that BFC 8, *Ornithogalum thrysoides*, is a quite different painting of Group B as opposed to BRI 52 which is one of the 4 Group A paintings. BFC has 28 extra paintings of Group B with common names. One anomaly is the occurrence of 7 shared paintings of Group B with common names. In BRI 43, *Erica cerinthoides*, there is an additional set of words written in the same handwriting "*Erica coris folio hispido cerinthoides africana Breynia*", which is the Latin polynomial given to the species by Jakob Breyn in his *Centuria prima* of 1678.

The handwriting in BRI is very distinctive and could well be the same as that used to write the notes accompanying the animal paintings in the Codex Witsenii, SAM; cf. FOL. 160 reproduced by Barnard (1947). This handwriting is not the same as that occurring on the botanical paintings which, according to Smith (1952) quoting a former Chief Archivist, Graham Botha, is identical with that in IPA. The handwriting of the notes in SAPL is also of a similar style. This could suggest that the artist wrote the names in BRI and the notes in the SAM animals, which are regarded as having been copied at the Cape for Nicolaas Witsen some time before 1692 (Barnard 1947).

A number of the common names differs slightly between BFC and BRI, most being differences in spelling which could be attributed to the home language of the copier, e.g. middags/middaghs; bloem/blom; Ringel/Rengel; —aense/—aense; sterre/starre. Some peculiar differences are noted here:

BFC 90: Pelloan Bloem	BRI 43: Pelicaen blom
BFC 78: Heutel	BRI 62: Huetel
BFC 17: Hyacins tuberosa	BRI 85: Hyasinta tuber-
peruanus	osus peruanus
BFC 70: Piramus infralia	BRI 89: Piramus in jitalia

These anomalies would indicate copying from the same original, but in BFC by a rather poorer copier of words.

Jessop (1965) pointed out that the common names in BRI must have been added to the bound volume, as many of them have been blotted on the verso of the preceding page.



FIG. 4.—*Wachendorfia paniculata* Burm. Top left, painting number 45 from the BRI florilegium, $\times 0,36$; top right, Tab. IX from Breynes's Prodomi (1739), $\times 0,5$. *Monsonia speciosa* L. Bottom left, Tab. XXI from Breynes's Prodomi (1739), $\times 0,5$; bottom right, painting number 22 from the BRI florilegium, $\times 0,36$.

ANNOTATIONS

The BRI volume was at one time in the possession of Johannes Burman as it was inscribed by him on 3 August 1755 [cf. fig. 1 of Jessop (1965)]. Burman also annotated every painting in BRI. Most of his annotations were probably done about the same time as the same dark ink and style of writing was used by him. This was done in the volume as is evidenced by the blotting of the ink on the verso of the preceding pages. He quotes many times Breynes's *Prodromi* of 1739 and his own *Rariorum Africanarum Plantarum* of 1738/39 using Latin polynomials. However, on BRI 112, *Antholyza ringens*, he cites Linnaeus's *Species Plantarum* of 1753 and quotes his description. Binomials were added by Burman using a finer pen. Additional annotations were also added in a larger clumsier handwriting using paler ink.

PUBLISHED WORKS

Paintings from both BFC and BRI are known to have been used in published works, namely, Breynes's *Prodromi* (1739) and Burman's *Rariorum Africanarum Plantarum* (1738/39). Mention has already been made of these by Jessop (1965) and by Gunn & Du Plessis (1978). However some extra observations not noted by them throw a different light on the relationships of the florilegia and the above publications.

The younger Breyne undoubtedly used the BFC paintings as the originals from which 15 of the engravings in the *Prodromi* of 1739 were copied. These paintings occur in both BFC and BRI but a very careful comparison of the water-colours and the engravings shows that the engravings were made

from BFC. All of these originals fall into the Group A paintings. Seven engravings can be linked to water-colours which occur only in BFC and these are all Group B paintings.

Of significance are three engravings which can be linked to water-colours of Group A found only in BRI. Tab. VII fig. 2 of *Gladiolus carneus* is taken from BRI 47. Gunn & Du Plessis (1978) compared this engraving with another quite different water-colour of the same species which occurs in both florilegia and is illustrated in the present article in Fig. 1. Tab. IX, fig. 1 in Breynes's *Prodromi* is of *Wachendorfia paniculata* which is taken from BRI 45 and is illustrated in the present article in Fig. 4. Of particular interest is the third example, *Monsonia speciosa* on Tab. XXI, fig. 2, which is taken from BRI 22 (cf. Fig. 4 in the present article). On the same Tab., fig. 1 is of *Senecio cymbalarifolius* which is represented in both florilegia, Group A paintings, and in the text is cited as being "*ex Flora nostra Capensis*". But in the text for *Monsonia* the Breynes state "*in Flora nostra Capensi*". This water-colour does not exist in BFC. From their statement it would appear that the Breynes had had access to a copy of this species, which had not been bound into BFC, or even access to BRI. If the latter were the case why then had the Breynes not reproduced more of the superb water-colours.

J. Breyne had collected together the paintings for BFC before his death in 1697. His son, J. P. Breyne, when mentioning the paintings in the *Prodromi* did not give exact details of their origin other than that they came from the Cape, e.g. Tab. XII, fig. 1—"*Huius iconem accepit Parens ex Capite bonae spei vivis coloribus pictam*".

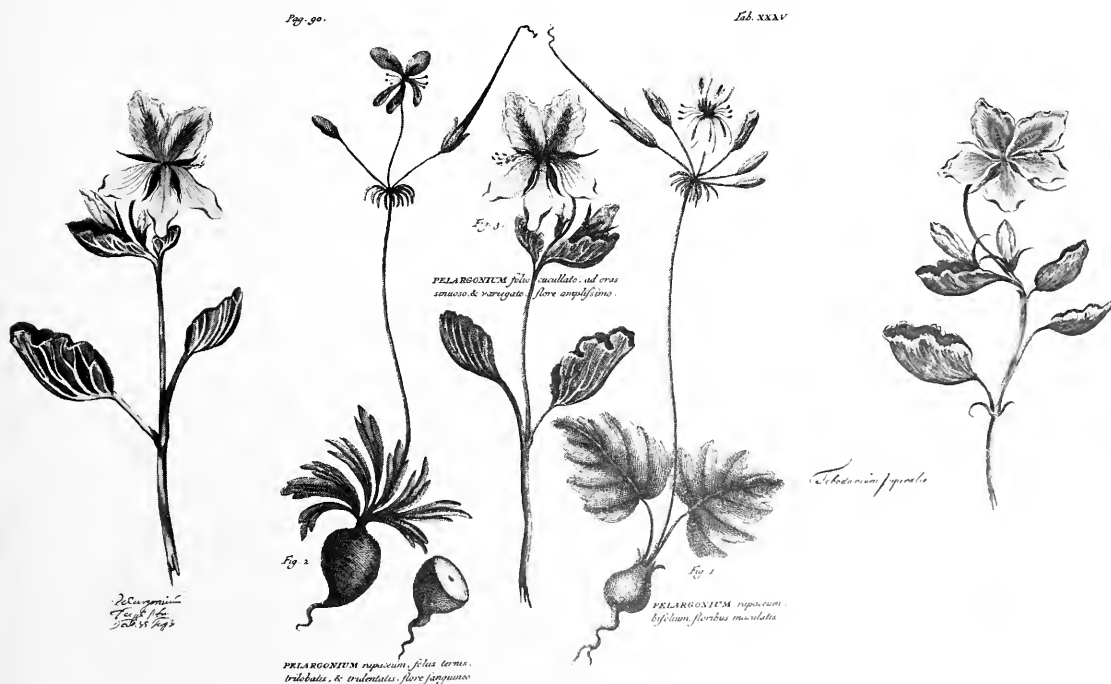


FIG. 5.—*Pelargonium cucullatum* (L.) L'Hérit. Centre, Tab. XXXV, Fig. 3, from Burman's *Rariores Africanarum Plantarum* (1738), $\times 0.5$; left, painting number 103 from the BRI florilegium, $\times 0.25$; right, painting number 54 from the BFC florilegium (Brenthurst reproduction), $\times 0.30$.

Burman's *Rariorum Africanarum Plantarum* contains descriptions and engravings of some Cape plants. Burman attributes 92 of them to the Codex Witsenii, 34 to Herbarium Witsenianum and 33 to the Collection or Codex Simon van der Stel. Of all these figured plants six can be identified as being almost identical to water-colours in BRI. In the text accompanying the plates he attributes five of the six species to the Collect. van der Stel. e.g. Tab. XII, fig. 2, "*atque haec in Collect. van der Stel eleganter depicta mihi obvenit, unde hanc exhibemus*". All of these species depicted are Group B paintings. The remaining 28 species attributed to the Collect. van der Stel do not occur in BRI. Therefore it must be assumed that Burman had all these plants reproduced as engravings from a volume which he knew was the Collect. van der Stel and that the five Group B copied water-colours in BRI came from that source. As stated by Jessop (1965) and by Gunn & Codd (1980) this volume is not traceable.

The remaining BRI water-colour depicted in Burman's work is of *Oxalis purpurea* on Tab. XXVII, fig. 3 and is attributed to the Codex Witsenii. This is the figure that Jessop was concerned about because of the hairiness and stamens which Burman had added. Reference to the text shows that Burman referred to other works in which the species was mentioned, namely those of Commelin who described his species as glabrous, of Breynia as hirsute (in fact only the calyx) and of Herman also as hairy and had thus adapted his figure accordingly. There is, of course, the possibility that the copier for BRI had merely omitted the hairs and stamens, which were present in the original.

In Fig. 5 of the present article showing *Pelargonium cucullatum*, the centre illustration is taken from Burman's work, Tab. XXXV. He cites in the text "& ex Collect. D. van der Stel hanc publici juris facimus". On the left in Fig. 5 there is the same species as depicted in BRI 103 and on the right is BFC 54. The similarity between the BRI water-colour and the Burman engraving is obvious. The BFC water-colour is rather far removed, but can be seen to bear some resemblance. Both water-colours belong to the Group B copied paintings. It has been shown earlier in this article that the BRI copies are probably truer copies of the originals than the BFC copies. One would then assume that the BRI and BFC paintings were copied from the same original which was in the Collect. van der Stel. The other two species of *Pelargonium* illustrated in this plate were copied from the Codex Witsenii and are almost identical to the water-colours attributed to Claudius in SAM, IPA and TCD.

One plate, Tab. LXXV, in Burman's work is of special interest. In it are depicted *Crassula capensis* (fig. 4) and an unidentifiable composite (fig. 5). The former is present in both BFC and BRI, but the latter is only in BFC. In the text Burman states for the *Crassula* "*Fructus nec semina adpicta sunt in Collect. D. van die Stel, unde hanc cum subsequente producimur*", the subsequent figure being the composite. This would indicate that the Breynia had had their painting copies from the Collect. van der Stel.

Barnard (1947) gives a detailed description of SAM which he says is part of the Codex Witsenii particularly as it is autographed by Witsen. The Codex contains 12 water-colours which Burman figured and attributed to the Codex Witsenii. These engravings were taken from SAM and not from the almost identical paintings in IPA, SAPL or TCD,

as a detailed comparison of the paintings and engravings shows a closer match with SAM. Many of the plates which Burman attributes to the Codex Witsenii can be traced to that very fine Codex, IPA, in Johannesburg. This has been discussed by Macnae & Davidson (1969).

CONCLUSIONS

The four early florilegia housed in Libraries in Pretoria, Johannesburg, Oxford and Leiden consist of the same basic set of water-colour paintings of Cape plants. These paintings can be divided into two distinct groups, A and B, on the style of painting and the quality of detail. The key volume is the florilegium, BRI, housed in Pretoria.

In BRI the quality of the Group A paintings is outstanding, as the paintings have more natural proportions, in some cases contain more and better details and were executed with good quality paint. They must be regarded as originals. The Group B paintings are all reasonable copies taken from another or, perhaps, several sources. The paper on which the paintings were executed is all of similar make and quality and is unfolded. All the paintings were executed at the Cape directly into the volume, as is indicated by the occurrence of Groups A and B randomly distributed through the volume, some on the same sheet and others even the same page. The volume was later properly bound in vellum. The paintings were nearly all numbered consecutively giving a series of numbers relevant only to BRI.

In BFC the Group A paintings are of poorer quality with sometimes fewer details depicted, they have altered unnatural proportions and were painted with a poorer quality water-colour paint. They all bear a number which corresponds to that in BRI, but are randomly arranged at the beginning of BFC. These paintings are undoubtedly copies of some of the Group A paintings in BRI, and are done on unfolded paper. The Group B paintings of which there are many more than in BRI, are likewise copies taken from a similar source as BRI. These are all done on folded paper which indicates that the copying was done at the Cape. The Group A and B paintings were copied separately on several different types of paper and then bound into a volume as late as 1724, with Group A paintings first and Group B's second. At this stage the pages or folios, not the paintings, must have been numbered consecutively.

The volumes, OXF and LD, are both sets of inferior copies with their numbering related to the folio numbers of BFC. This indicates that they must have been copied from BFC after 1724. The copies in LD were acquired at different times, the Group A paintings in 1779 and the Group B paintings in 1778, possibly from the estate of Seba according to Gunn & Du Plessis (1978).

Burman used some Group B paintings from which engravings were made and published in his *Rariorum Africanarum Plantarum* of 1738/39. He stated that they came from the collection of Simon van der Stel. This could indicate that all the Group B paintings were copies for BRI and BFC from one of the volumes of paintings owned by Van der Stel and now untraceable.

My conclusions from a comparison of BRI and BFC are that the BRI volume was painted first with Group A paintings painted from live plants and the Group B paintings copied at the Cape from Van der Stel's collection of paintings. They were then

number consecutively. The same artist, or perhaps another one, must have copied some of the BRI Group A paintings for Jakob Breyne, and yet another artist copied the Group B paintings for Breyne possibly from the same collection of Van der Stel. These paintings were eventually bound in 1724 and the pages numbered. The other two florilegia, OXF and LD must then have been copied from BFC.

The main questions that remain are—who were the artists and when was the first florilegium painted? The first question will probably remain as a point for speculation and remain unanswered for ever, as none of the artists active at the Cape in its early days ever signed a copy of his work. When the BRI florilegium was executed can be roughly deduced from certain facts. Jakob Breyne must have acquired his collection of paintings before he died in 1697. Thus for BFC Group A paintings to have been copied from BRI, BRI must have been in existence before 1697. As Breyne did not use any of the BFC paintings to illustrate the Cape plants depicted in his *Centuria* of 1678, it can be assumed that he acquired BFC after 1678. Gunn & Du Plessis (1978) mention several artists who were active at the Cape from the mid-1680's to the mid-1690's. It is reasonable to assume that BRI was painted during that period.

As Gunn & Codd (1980) state, botanists in South Africa must be grateful to the Benthurst Press for publishing the complete BFC florilegium in colour. This statement I certainly endorse. Already available as reproductions are the superb facsimile edition in colour of TCD (Waterhouse, 1979), the sepia reproduction of IPA (Kennedy, 1967) and the rather poor black and white reproduction of the SAM paintings (Barnard, 1947), all of which give botanists an idea of the paintings in those volumes and something with which to make comparisons. As yet BRI, SAPL, OXF and LD have not been reproduced in any form to make them generally available to researchers. Gunn & Codd (1980) also point to the possibility of the existence of "undiscovered" manuscripts and volumes in libraries and archives in Europe, particularly in the rich collections at Leiden. It is hoped that this article will add to the increasing literature on early Cape florilegia and that at some time in the future new information will come to light that will solve some of the unanswered problems.

ACKNOWLEDGMENTS

Sincere thanks are due to the Benthurst Library in Johannesburg for allowing examination of the original copy of the Breynes's *Flora Capensis*. This also applies to the Africana Museum in Johannesburg and to the South African Museum and South African Public Library in Cape Town for permitting examination of the original codices in their collections.

Useful discussions were held with Dr L. E. Codd and with Miss M. D. Gunn. Mrs A. Romanowski is thanked for her reproduction of the water-colour paintings.

UITTREKSEL

'n Aantal vroeë Kaapse florilegiums en kodekse bestaan in biblioteke in Europa en Suid-Afrika. Vier van hierdie florilegiums is naverwant en word in die Benthurst-biblioteek, Johannesburg, die Navorsingsinstituut vir Plantkunde, Pretoria, die Bodley-biblioteek, Oxford en die Rijksherbarium, Leiden, gevind. Die florilegiums van die eerste twee word met mekaar vergelyk en in detail in hierdie artikel bespreek. Die artikel het ontstaan na aanleiding van 'n resensie van die Benthurst-weergawe van Jakob en Johan Philipp Breyne se *Flora Capensis* wat vir hierdie uitgawe van *Bothalia* opgestel is. Voortspruitende uit die vergelyking word 'n nuwe verklaring vir die onderlinge verwantskappe en die oorsprong van die vier florilegiums voorgestel. Die sleutelvolume is die florilegium in die Navorsingsinstituut vir Plantkunde, Pretoria.

REFERENCES

- BARNARD, K. H., 1947. A description of the *Codex Witsenii* in the South African Museum. *Jl S. Afr. Bot.* 13: 1-52.
- BREYNE, J., 1678. *Exoticarum Aliarumque Minus Cognitarum Plantarum Centuria Prima*, etc. Danzig: Rhettius.
- BREYNE, J. & BREYNE, J. P., 1739. *Prodromi Fasciculi Rariorum Plantarum Primus et Secundus*, etc. Danzig.
- BURMAN, J., 1738-1739. *Rariorum Africanarum Plantarum*, etc. Amsterdam: H. Boussiere.
- CHURCHILL, W. A., 1935. *Watermarks in paper in Holland, England, France etc. in the XVII & XVIII centuries and their interconnections*. Amsterdam: Menno Hertzberger.
- EDWARDS, P., 1964. Some manuscripts relating to South African botany in the William Sherard Collection in the Bodleian Library at Oxford. *Jl S. Afr. Bot.* 30: 103-105.
- GUNN, M. D. & DU PLESSIS, E., 1978. Introduction and text in *The Flora Capensis of Jakob and Johan Philipp Breyne*. Johannesburg: Ad. Donker for the Benthurst Press.
- GUNN, M. D. & CODD, L. E., 1980. *Botanical collectors in Southern Africa*. Cape Town: Balkema. In press.
- HEAWOOD, E., 1924. The use of watermarks in datin old maps and documents. *Geogl. J.* 63: 391-410.
- HEAWOOD, E., 1950. *Watermarks mainly of the 17th and 18th centuries*. Hilversum: The Paper Publications Society (Monumenta Chartae Papyraceae, No. 1).
- JAFFE, A., 1930. Zur Geschichte des Papieres und Seiner Wasserzeichen. *Pfalzische Heimatkunde* (26 Jahrgang), 1930, Heft 3/4: 3-29.
- JESSOP, J. P., 1965. A volume of early water-colours in the Library of the Botanical Research Institute, Pretoria. *Jl S. Afr. bot. Soc.* 6: 38-52.
- KENNEDY, R. F., 1967. *Catalogue of pictures in the Africana Museum*, Vol. 2, C307-738. Johannesburg.
- MACNAE, M. M. & DAVIDSON, L. E., 1969. The volume "*Icones Plantarum et Animalium*" in the Africana Museum, Johannesburg; and its relationship to the *Codex Witsenii* quoted by Jan Burman in his "*Decades Rariorum Africanarum Plantarum*". *Jl S. Afr. Bot.* 35: 65-81.
- OLIVER, E. G. H., 1980. Book review: The *Flora Capensis* of Jakob and Johan Philipp Breyne, ed. M. Gunn & E. du Plessis. *Bothalia* 13: 000.
- SMITH, A. H., 1952. *Notes on the Claudius water-colours in the Africana Museum*. Johannesburg: Africana Museum, Frank Connock Publication No. 1.
- TACHARD, G., 1686. *Voyage de Siam*, etc. Paris: Arnould Seneuze & Daniel Horthemels.
- TACHARD, G., 1689. *Second Voyage du Père Tachard*, etc. Paris: Daniel Horthemels.
- WATERHOUSE, G., 1932. *Simon van der Stel's Journal of his Expedition in Namaqualand*, 1685-86. Dublin: Longmans Green.
- WATERHOUSE, G., 1979. *Simon van der Stel's Journey to Namaqualand in 1685*. Cape Town & Pretoria: Human & Rousseau.

Musci austro-africani II. Bryophyte collections in southern Africa and southern African type specimens in the National Herbarium, Pretoria

R. E. MAGILL*

ABSTRACT

A brief review of bryological collections and collectors in southern Africa introduces a catalogue of southern African type specimens housed in the National Herbarium, Pretoria. The type catalogue, arranged alphabetically by basionym, includes correct names, type status and label data.

RÉSUMÉ

MUSCI AUSTRO-AFRICANI II. COLLECTIONS DE BRYOPHYTES EN AFRIQUE AUSTRALE ET SPÉCIMENS-TYPES DE L'AFRIQUE AUSTRALE DANS L'HERBIER NATIONAL À PRETORIA

Après une introduction consacrée à une brève revue des collections bryologiques et des récolteurs en Afrique australe, on présente un catalogue des spécimens-types de l'Afrique australe qui sont conservés dans l'Herbier National à Pretoria. Ce catalogue est disposé en ordre alphabétique par basionyme; il inclut les noms corrects, le statut du type et les données des étiquettes.

It has become obvious, through examination of several recent revisions dealing in part with southern African taxa, that the distribution and the content of bryophyte collections housed in South African herbaria are not fully understood. Although most southern African herbaria have some bryophyte material, most of the specimens housed in the Flora of Southern Africa area, are at the five larger herbaria (BOL, GRA, NBG, NH, PRE). In connection with the current research on southern African mosses, the curators of these herbaria have made their collections available to the Botanical Research Institute (PRE) on temporary loan.

Each of these herbaria has a unique collection with only a limited amount of overlap. For reasons discussed below, the National Herbarium (PRE) has the greatest overlap with each of the other herbaria, as well as its own distinctive collection (Table 1).

A survey of each of these collections substantiates Sim's (1926) supposition that specimens gathered by the early collectors are not represented in South Africa. Collectors such as W. J. Burchell, J. Breutel, J. F. Drège, W. H. Harvey, C. W. L. Pappe, C. Thunberg and F. Wilms made small but very important collections of bryophytes, that were apparently sent to Europe for investigation and distribution. Dr A. Rehmann is the only early collector with his specimens represented in substantial numbers in southern African herbaria. After each of his collecting trips to southern Africa, Rehmann distributed his mosses in an exsiccata entitled "Musci Austro-africani" (cf. Dixon & Gepp, 1923). Rehmann's contact with P. MacOwan, H. Bolus and J. Medley Wood and the contributions made by these botanists to the exsiccata, accounts for the presence of sets at BOL, GRA and NH. Each of these sets, although containing numerous identical specimens, contains several collections not found in the other two sets. A pre-distribution set of the exsiccata was apparently sent to C. Müller, who in 1899, described a large number of the specimens as new species. It is indeed unfortunate that inconsistency exists between the citation of specimen numbers by Müller and Rehmann, since the specimens of the exsiccata probably represent the only extant type material.

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TABLE 1.—Distribution of major or historic collections of South African bryophytes

	BOL	GRA	NBG	NH	PRE
Arnell.....	2	—	—	—	3
Barnard.....	—	—	1	—	2
Bosman.....	—	—	—	—	1
Bottomley.....	—	—	—	—	1
Bryhn.....	—	—	—	5	—
Dieterlen.....	—	—	5	—	5
Doidge.....	—	—	—	—	1
Ecklon.....	—	5	5	—	—
Esterhuysen.....	1	—	—	—	2
Garside.....	1	—	—	—	—
Jacot Guillarmod.....	—	2	—	—	2
McLea.....	4	4	—	—	4
Magill.....	5	—	—	—	1
MacOwan.....	—	3	5	—	—
Pappe.....	—	—	3	—	—
Pillans.....	1	—	—	—	5
Pegler.....	3	—	—	—	2
Rehmann.....	4	4	—	4	2
Schelpke.....	1	—	—	—	3
Sim.....	5	5	—	—	1
Thorne.....	—	—	1	—	2
Tyson.....	—	—	1	—	2
Vorster.....	—	—	—	—	1
Wager.....	5	2	—	—	1
Wood (Medley Wood).....	—	—	—	1	3
Zeyher.....	—	5	5	—	—

Key: 1—First set or major collection.
2—Major duplicate set.
3—Duplicates.
4—Exsiccata.
5—Representative specimens.

H. A. Wager (1917) and T. R. Sim (1915) began the first collections of bryophytes to be retained in southern Africa. Nevertheless, specimens of both collectors are also well-represented in the British Museum, because of their correspondence with H. N. Dixon.

Wager made a random collection of southern Africa mosses. His specimens are rarely numbered and location data are generally restricted to the listing of a nearby town. On the other hand, Sim made extensive collections throughout southern Africa and Rhodesia. His specimens are mostly numbered and frequently have labels with data in addition to locality, i.e. habitat, association. Most of Sim's collections were identified or verified from duplicates sent to Dixon. Sim's enthusiasm as a bryologist was apparently infectious as he was able to encourage a

large number of amateur and professional botanists to collect bryophytes for him. The collections of both Wager and Sim were bequeathed to the National Herbarium upon the deaths of these first South African bryologists.

Bolus Herbarium

The Bolus Herbarium has maintained curatorial and research activities on the bryophyte collection since Sim (1926) published his *Bryophytes of Southern Africa* and, before the recent renovation of the collection at PRE, was the only South African herbarium to incorporate nomenclatural and taxonomic changes. The bryophyte collection at BOL contains c. 7 000 specimens including a set of the Rehmann exsiccata (*pro parte*), an important collection of Cape Peninsula bryophytes by N. S. Pillans, east African collections by R. A. Dümmer, F. Eyles and E. A. Schelpe and a large extra-African reference collection. A substantial backlog of approximately 1 500 unidentified South African collections by E. Esterhuysen, S. Garside and E. A. Schelpe is currently being identified as part of the author's research and the first set of these specimens will be housed at BOL. The bryophyte collections at BOL are in packets mounted on standard herbarium sheets, with one to several packets per sheet. The sheets occasionally have notes and illustrations attached. The Rehmann specimens are kept separate in a vertical file packet system.

Albany Museum

The bryophyte collection at the Albany Museum (GRA) began with the collections of P. MacOwan and his exchange with several overseas bryologists. Although most of his own collections were sent out on exchange, a few of his specimens are present in the collection. The herbarium contains c. 1 300 specimens, including a set of the Rehmann exsiccata (*pro parte*) and a small extra-African reference collection. The specimens are in packets mounted individually on standard herbarium sheets and the collection has been annotated to conform with Sim's (1926) *Bryophytes of Southern Africa*. The Rehmann exsiccata are maintained separately in individual unmounted packets and the MacOwan specimens are mounted, exposed or in packets, in light-weight paper folders, approximately the size of herbarium sheets. Most of the modern collection is made up of duplicates from Wager and Sim, however GRA has recently received specimens collected by A. Jacot Guillarmod from the eastern Cape.

Compton Herbarium

The Compton Herbarium (NBG) obtained its bryophyte collection through acquisition of the South African Museum Herbarium. This collection, considered the oldest in southern Africa and containing numerous phanerogam collections of the early collectors cited above, holds only a few bryophyte specimens of Ecklon, Pappe and Zeyher. As curator of the collection, MacOwan was responsible for the build-up of the very large extra-African reference collection, but he left less than a dozen of his own specimens at SAM, when he moved to the Albany Museum. For the most part, the collection is made up of specimens gathered during the 1920–1930's by K. H. Barnard, C. Thorne and W. Tyson, primarily in the western Cape and South West Africa. The c. 2 500 specimens, including a set of the east African collections of R. A. Dümmer, are mounted in packets, one to several per standard herbarium sheet. Most

of the South African collections were identified or annotated by Sim and therefore follow his nomenclature and taxonomy.

Natal Herbarium

The South African specimens at the Natal Herbarium consist primarily of the Rehmann exsiccata, however these are supplemented by specimens collected in Natal by J. Medley Wood, H. Bryhn and L. Tittlestad. A large extra-African collection was obtained through an exchange with N. Bryhn and includes a set of his Canary Island specimens. The specimens are mounted, exposed or in packets, on half herbarium sheets, one specimen per sheet. The southern African specimens have been annotated to conform nomenclaturally and taxonomically with Sim (1926).

National Herbarium, Pretoria

The bryophyte collection at the National Herbarium (PRE) is the largest in southern Africa, both in respect to African and extra-African holdings. The majority of the collection is made up of the private collections of Sim and Wager and the holdings of the Transvaal Museum acquired in 1953. The collection has been increased over the years by the work of several botanists, e.g. S. Arnell, M. Bosman, A. M. Bottomley, E. M. Doidge, R. E. Magill and P. J. Vorster and through an intermittent cryptogamic exchange programme.

Wager deposited duplicates of his collections at PRE, GRA and the Transvaal Museum. These specimens correspond in number and nomenclature to his checklist of South African mosses (1917). Unfortunately, these specimens have no collection numbers and only brief location data. His personal herbarium was left to PRE and incorporated in 1951. These specimens generally have collection numbers corresponding to those used in several publications by Dixon (1920, 1929). Wager's practice of incorporating any subsequent collection in a single packet for each species is regrettable, as this has resulted in a few type specimens being mixed with other collections.

The Sim specimens represent the largest and most extensive collection of southern African bryophytes. In preparation for his text, "The Bryophyta of South Africa", Sim collected throughout southern Africa and Rhodesia and persuaded many collectors to send him specimens. During his research, Sim had access to each of the above collections and frequently kept duplicates in exchange for identifications. One important note in this context was Sim's annotation and up-dating of the Rehmann exsiccata for BOL, GRA and NH. Sim kept a scrap, whenever possible, and this has resulted in an almost complete set of the exsiccata at PRE.

The bryophyte collection at PRE had been mounted in various sized packets with one to 10 packets per herbarium sheet (Fig. 1). In an effort to make the collection more accessible, the entire collection has been repacketed and shifted to a vertical file packet system (Figs 2 & 3). The specimens are now filed by family in phylogenetic order (cf. Crosby & Magill, 1977 and Magill & Schelpe, 1979).

The species are filed alphabetically under the genus and each genus, when possible, has been divided into southern African, other African and extra-African groups. In addition, the southern African species are colour-coded by country and/or province. The mosses have been annotated to follow the nomenclature of Index Muscorum or recent revisions and the types are filed under annotated names.

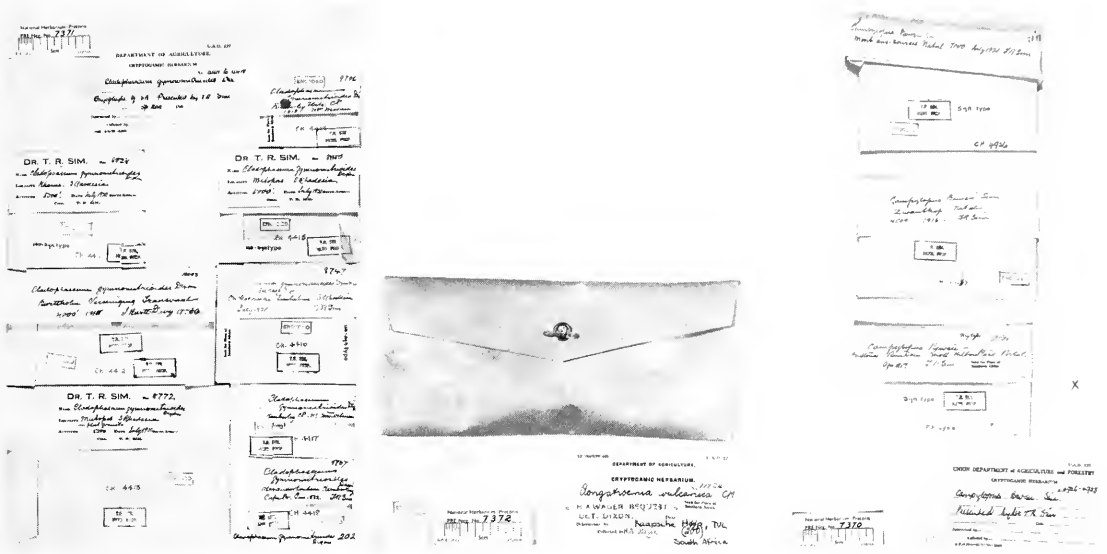


FIG. 1.—Three herbarium sheets illustrating various packet sizes and mounting procedure prior to renovation of PRE bryophyte collection.



FIG. 2.—New bryophyte cabinets for vertical file packet system, showing drawers with removable specimen boxes.

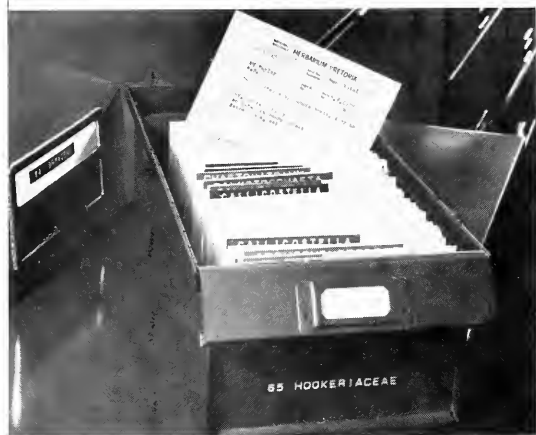


FIG. 3.—Close-up of specimen box, illustrating filing system and new packet.

In connection with the current research on the moss flora, a card index of all southern African names has been compiled and the South African collections searched for type material. A total of 206 southern African types (284 specimens) has been identified at PRE and are listed below as an aid to researchers interested in taxa present in southern Africa. The citation is alphabetical by basionym; when necessary, this is followed by the correct name. The status of the PRE specimen(s) and label data, collector and numbers are also listed under each name. No attempt to choose lectotypes has been undertaken here: citation of a single syntype indicates only current holdings at PRE.

CATALOGUE OF SOUTHERN AFRICAN TYPE SPECIMENS IN THE NATIONAL HERBARIUM, PRETORIA

- Acanthocladia transvaaliense* Thér. & Dix.
= *Heterophyllum transvaaliense* (Thér. & Dix.) Thér. & P. Varde
Isotype: Transvaal, Woodbush, Wager s.n.
Amblystegium filiforme Wag. & Wright
= *Pseudoleskea leskeoides* (Par.) C. Müll.
Isotype: Natal, Van Reenen, Wager s.n.
Anoetangium assimilis Broth. & Wag.
= *A. wilmsianum* (C. Müll.) Par.
Isotype: Natal, Wager s.n.
Aongstroemia abruptifolia C. Müll.
= *Dicranella subsubulata* (C. Müll.) Jaeg.
Isotype: Cape, Esternek above Knysna, Rehmann 25.
A. gymnomitrioides Dix.
= *Cladophascum gymnomitrioides* (Dix.) Dix.
Iso-syntypes: Rhodesia, Zimbabwe, Sim 8747; Matopos, Sim 8772, 8850; Khami, Sim 8838.
Aptychus sphaeropyxis C. Müll.
= *Sematophyllum sphaeropyxis* (C. Müll.) Broth.
Isotype: Natal, Inezanga, Rehmann 372.
Archidium acanthophyllum Snider
Paratype: Natal, Wager s.n., July 1908.
A. julicaule C. Müll.
Iso-syntype: Cape, Cape Town, Rehmann 426.
Barbula afroruralis C. Müll.
= *Tortula ruralis* (Hedw.) Gaertn., Meyer & Scherb.
Isotype: Cape, near Stinkwater, Rehmann 114.
B. brachyachme C. Müll.
= *Tortula hildebrandtii* (C. Müll.) Broth.
Isotype: Cape, Cape Town, Rehmann 107.
B. deserta C. Müll.
= *Desmatodon convolutus* (Brid.) Grout
Isotype: Cape, Cape Town, Rehmann 96.
B. eutrichostomum C. Müll.
= *Tortella humilis* (Hedw.) Jenn.
Isotype: Cape, near Blanco, Rehmann 91.

- B. natalensis* C. Müll.
= *B. indica* (Hook.) Spreng.
Isotype: Natal, Port Durban, Rehmann 104.
B. oranica C. Müll.
= *Tortula hildebrandtii* (C. Müll.) Broth.
Isotype: Orange Free State, Bethlehem, Rehmann 126.
B. reticularia C. Müll.
= *Tortula papillosa* Wils. in Spruce
Isotype: Cape, Cape Town, Rehmann 106.
B. salisburyensis Dix.
Isotype: Rhodesia, Salisbury, Eyles 596.
B. trichostomacea C. Müll.
= *Trichostomopsis australasiae* (Hook. & Grev.) Robins.
Isotype: Cape, Rondebosch, Rehmann 97.
B. trivialis C. Müll.
= *Trichostomopsis trivialis* (C. Müll.) Robins.
Isotype: Orange Free State, Kadziberg, Rehmann 99.
Bartramia africana C. Müll.
= *Philonotis africana* (C. Müll.) Rehm. ex Par.
Isotype: Natal, Inanda, Rehmann 93.
B. afrofontana C. Müll.
= *Philonotis afrofontana* (C. Müll.) Par.
Iso-syntype: Orange Free State, Kadziberg, Rehmann 192.
B. afrostricta C. Müll.
= *B. substricta* Schimp. in C. Müll.
Iso-syntypes: Cape, Cape Town, Rehmann 203, 204.
B. permana C. Müll.
= *Philonotis androgyna* (Hampe) Jaeg.
Isotype: Cape, near Belvedere, Rehmann 191.
B. squarriifolia Sim
Syntypes: Transvaal, Witpoortje, Moss s.n.; Cape, Disa Gorge, Sim 9166; Paarl Mountain, Sim 9639; Schoonekloof, Pillans 4089; Table Mountain, Mitchell s.n.; Bews s.n.
B. subasperrima C. Müll.
= *B. compacta* Hornsch.
Isotype: Cape, Cape Town, Rehmann 213.
Brachythecium afroalbicans Dix.
= *Juratzkaea leptura* (Tayl.) Weber ex Buck
Isotype: Cape, Blinkwater Ravine, Table Mountain, Bews s.n. (Sim 8634).
B. afrosalebrosum C. Müll.
= *B. implicatum* (Hornsch.) Jaeg.
Iso-syntype: Orange Free State, Kadziberg, Rehmann 383b.
B. afrovelutinum C. Müll.
= *B. implicatum* (Hornsch.) Jaeg.
Isotype: Cape, mountains near Rondebosch, Rehmann 379.
B. erythropxyxis C. Müll.
= *B. implicatum* (Hornsch.) Jaeg.
Isotype: Natal, Inanda, Rehmann 382.
B. knysnae C. Müll.
= *B. implicatum* (Hornsch.) Jaeg.
Iso-syntype: Cape, between Knysna and Belvedere, Rehmann 387.
B. pinnatum Dix.
Isotype: Cape, Knysna, Wager 520.
Braunia maritima C. Müll.
= *Hedwigium integrifolium* (P. Beauv.) Dix. in C. Jen.
Iso-syntype: Cape, Table Mountain, Rehmann 306.
B. peristomata Dix.
= *Leucodon maritimus* (Hook.) Wijk & Marg.
Iso-syntypes: Rhodesia, Zimbabwe Ruins, Sim 8750, 8778, 8793, 8809; Fort Victoria, Sim 8843.
Breutelia angustifolia Rehm. ex Sim
Holotype: Transvaal, Mac-Mac, McLea s.n. (Rehmann 538).
B. tabularis Dix. in Sim
Iso-syntypes: Cape, Platteklip Ravine, Table Mountain, Sim 9277; Pillans 3335, 4899.
Bryum acuminatum Sim, hom. illeg.
= *B. similis* Schelpe
Holotype: Natal, Cathkin, Owen 15.
B. atterimum C. Müll. ex Sim
Holotype: Cape, between Knysna and Belvedere, Rehmann 235.
B. liliputanum C. Müll.
= *Brachymenium dicranoides* (Hornsch.) Jaeg.
Isotype: Cape, Cape Town, Rehmann 241.
B. oranicum C. Müll.
= *B. argenteum* var. *australe* Dix.
Isotype: Orange Free State, Kadziberg, Rehmann 260.
B. rigidiscus Dix.
= *B. bicolor* Dicks.
Syntypes: Natal, Van Reenen's Pass, Wager 74; Rhodesia, Zimbabwe, Sim 8790; Khami Ruins, Sim 8839.
Calymperes victoriae Dix.
Isotype: Rhodesia, Victoria Falls, Sim 8879.
Calypothecium africanum Broth.
= *C. hoehneltii* (C. Müll.) Argent
Iso-syntype: Cape, Knysna, Rehmann 332.

- Campylopus angustinervis* Dix.
=Microcampylopus perpusillus (Mitt.) Broth.
Iso-syntypes: Transvaal, Belfast, Wager 884; Rhodesia, Matopos, Sim 8862; Zimbabwe, Sim 8806.
- C. bewsii* Sim.
Syntypes: Natal, Knoll, Hilton Road, Sim 9838; Mount aux Sources, Sim 9891.
- C. echinatus* Sim
=C. introflexus (Hedw.) Brid.
Syntypes: Cape, near Cape Town, Rehmann 67; Camps Bay, Rehmann 69; Knysna, Rehmann 72; Table Mountain, Bews s.n. (Sim 8604); Pirie Forest, Sim 8581B; Natal, Murchison Flats, Sim 9837.
- C. edwardsii* Sim
=C. olivaceonigrans (C. Müll.) Par.
Holotype: Transvaal, Johannesburg, Edwards s.n. (Sim 9836)
- C. pseudojulaceus* Sim, hom. illeg.
=C. simii Schelpe.
Holotype: Orange Free State, Kadziberg, Rehmann 58.
- C. symonsii* Sim
Syntypes: Natal, Giant's Castle, Symons s.n. (Sim 9843, 9835); Mount aux Sources, Gibb s.n.
- Chamaebryum pottiioides* Thér. & Dix.
Syntypes: Cape, Cape Town, Wager 633 cfr. 654, 653.
- Cupressina anotis* C. Müll.
=Ectropothecium regulare (Brid.) Jaeg.
Isotype: Cape, mountains near Esternek, Rehmann 413.
- Dicranella rigida* Dix. in Sim
Holotype: Cape, Paarl, Sim 9633.
- D. symonsii* Dix.
=Anisothecium symonsii (Dix.) Broth.
Isotype: Natal, Giant's Castle, Symons s.n. (Sim 8665).
- Dicranoloma entabeniense* Magill
Holotype: Transvaal, Soutpansberg, Entabeni Forest, Bottomley PRE-CH3381.
- Dicranum atroluteum* C. Müll.
=Campylopus atroluteus (C. Müll.) Par.
Iso-syntype: Cape, Cape Town, Rehmann 63.
- D. bartramiaeum* C. Müll.
=Campylopus atroluteus (C. Müll.) Par.
Isotype: Cape, Cape Town, Rehmann 37.
- D. catarractilis* C. Müll.
=Campylopus catarractilis (C. Müll.) Par.
Isotype: Cape, Devil's Peak, Rehmann 64.
- D. chlorotrichum* C. Müll.
=Campylopus chlorotrichus (C. Müll.) Par.
Iso-syntypes: Cape, Montagu Pass, Rehmann 53; Knysna, Rehmann 53b.
- D. inandae* C. Müll.
=Campylopus purpurascens Lor.
Isotype: Natal, Inanda, Rehmann 43.
- D. leucobasis* C. Müll.
=Campylopus introflexus (Hedw.) Brid.
Isotype: Cape, Montagu Pass, Rehmann 71.
- D. longescens* C. Müll.
=Campylopus clavatus (R. Br.) Wils.
Isotype: Cape, near Esternek, Rehmann 41.
- D. purpureoaurum* C. Müll.
=Campylopus purpurascens Lor.
Iso-syntype: Orange Free State, Liebenbergsvley, Rehmann 59.
- D. serridorsum* C. Müll.
=Campylopus catarractilis (C. Müll.) Par.
Isotype: Cape, Table Mountain, Cape Town, Rehmann 45.
- D. stenopelma* C. Müll.
=Campylopus stenopelma (C. Müll.) Rehm. ex Par.
Iso-syntype: Cape, near Esternek, Rehmann 52.
- D. tenax* C. Müll.
=Campylopus stenopelma (C. Müll.) Rehm. ex Par.
Isotype: Cape, near Blanco, Rehmann 54.
- Didymodon afrorubellus* Broth. & Wag. ex Dix.
Isotype: Natal, Van Reenen's Pass, Wager 79.
- D. knysnae* Rehm. ex Sim
=D. xanthocarpus (C. Müll.) Magill
Holotype: Cape, Port Elizabeth, Rehmann 83.
- D. pottii* Dix.
=D. dimorphus (C. Müll.) Broth.
Isotype: Orange Free State, Bloemfontein, Eagles Nest, Potts s.n. (Sim 8663).
- D. subfontanus* Dix. in Sim
Isotype: Transvaal, Witpoortje, Moss 10322.
- Dimerodontium africanum* C. Müll.
Iso-syntype: Cape, mountains near Rondebosch, Rehmann 354.
- D. carnifolium* C. Müll.
=Dimerodontium africanum C. Müll.
Isotype: Cape, mountains near Rondebosch, Rehmann 358.
- Diplostichum africana* C. Müll.
=Eustichia africana (C. Müll.) Par.
Isotype: Orange Free State, above Kadziberg, Rehmann 279.
- Distichophyllum taylorii* Sim
Holotype: Cape, near Wilderness, Taylor s.n. (Sim 10281).
- Ditrichum spirale* Dix.
Isotype: Cape, Gaika's Kop, D., B. & M. Henderson 232.
- Drepanocladus hallii* Broth. & Dix.
Isotype: Cape of Good Hope, Hall 7.
- D. sparsus* C. Müll.
Isotype: Orange Free State, Kadziberg, Rehmann 398.
- Drepanophyllaria caudicaulis* C. Müll.
=Hygroamblystegium caudicaule (C. Müll.) Broth.
Isotype: Cape, Devils Peak, Rehmann 404.
- Ectropothecium brevisetum* Dix., hom. illeg.
=E. brachycarpum (Dix.) Magill
Isotype: Moçambique, Shirindjen, Junod 331.
- Entodon cymbifolius* Wag. & Dix.
Isotype: Transvaal, Moorddrift, Waterberg, Wager 408.
- E. natalensis* Rehm. ex C. Müll.
Isotype: Natal, Van Reenen's Pass, Rehmann 331.
- Ephemerella nervosa* Dix.
=Ephemerum nervosum (Dix.) Schelpe
Iso-syntype: Cape, King William's Town, Wager 1082b.
- Erpodium distichum* Wag. & Dix.
Iso-syntype: Transvaal, Barberton, Wager 279.
- E. transvaaliense* Broth. & Wag. in Dix.
Isotype: Transvaal, Wolhuter's Kop, Wager 189.
- Fabronia wageri* Dix.
Isotype: Cape, Cape Town, Wager 5.
- F. victoriae* Dix.
Isotype: Rhodesia, Victoria Falls, Sim 8943.
- Fissidens aciphyllus* Dix.
Isotype: Natal, Port St Johns, Wager 927.
- F. amblyophyllus* C. Müll.
Iso-syntype: Natal, Inanda, Rehmann 285.
- F. aristatus* Sim
=F. simii Schelpe
Syntypes: Natal, Maritzburg, Sim 9903, 9907, 9909.
- F. borgenii* Hampe var. obtusifolius Dix.
Isotype: Natal, Van Reenen, Wager 166.
- F. brevisetum* Sim
=F. scleromitrius (Besch.) Broth.
Holotype: Natal, New Hanover, Sim 9906.
- F. calochlorus* Dix.
Iso-syntypes: Rhodesia, Victoria Falls, Sim 8891, 8882.
- F. corrugatulus* Dix.
Iso-syntypes: Rhodesia, Victoria Falls, Sim 8885, 8904.
- F. dubiosus* Dix.
Isotype: Rhodesia, Victoria Falls, Palm Grove, Sim 8819.
- F. enervis* Sim.
Syntypes: Natal, Maritzburg, Sim 9899, 9900; Nottingham Road, v. d. Bijl s.n. (Sim 8648).
- F. hoeegii* P. Varde.
Iso-syntype: Natal, Umgeni near Pietermaritzburg, Hoeg 423, 430, 432.
- F. hyalobasis* Dix. in Sim
Isotype: Transvaal, Moorddrift, Wager 406.
- F. ischyrobryoides* C. Müll.
=F. marginatus Schimp. in C. Müll.
Isotype: Cape, Devils Peak, Rehmann 290.
- F. latifolius* Dix.
Iso-syntypes: Rhodesia, Zimbabwe, Sim 8766, 8807, 8753, 8761, 8768; Khami Ruins, Sim 8841; Matopos, Sim 8856.
- F. microandrogynus* Dix.
Isotype: Rhodesia, Bulawayo, Wager 895.
- F. papillifolius* Dix.
=F. urceolatus Wag. & Dix. in Sim
Isotype: Natal, Albert Falls, Umgeni Nook, Sim 8709.
- F. parvilimbatus* Sim
Syntypes: Natal, Greenkoppies, J. Sim s.n. (Sim 9915); New Hanover, Sim 9905; Albert Falls, Sim 9912.
- F. pectinidens* Dix.
Isotype: Natal, Port St Johns, Wager 936.
- F. perpaucifolius* Dix. & Sim
Isotype: Cape, Stellenbosch, Wager 647.
- F. pycnophyllus* C. Müll.
Isotype: Cape, Cape Town, Rehmann 293.
- F. rehmannii* C. Müll.
=F. glaucescens Hornsch.
Isotype: Natal, Inanda, Rehmann 282d.
- F. stellenboschianus* Dix. in Sim
Isotype: Cape, Stellenbosch, Wager 612.
- F. urceolatus* Wag. & Dix.
Isotype: Transvaal, Pretoria, Wager 264.
- F. wageri* Dix. in Wag.
Isotype: Natal, Umkomaas, Wager s.n.
- Fontinalis duthieae* Sim
=Wardia hygrometrica Harv. in Hook.
Holotype: Cape, Cape Town, Platteklip, Sim 9389.
- Funaria longicollis* Dix.
Iso-syntypes: Rhodesia, Zimbabwe, Sim 8735, 8796, 8797; Khami Ruins, Sim 8842.

- Glyphomitrium marginatum* Wag. & Dix.
 =*Pythomitrium marginatum* (Wag. & Dix.) Dix.
 Iso-syntype: Transvaal, Kaapsche Hoop, Wager 298.
- Grimmia austropatens* C. Müll.
 =*Grimmia apocarpa* Hedw.
 Isotype: Cape, Table Mountain, Rehmann 137.
- G. caffra* C. Müll.
 =*G. apocarpa* Hedw.
 Isotype: Orange Free State, Witteberge above Kadziberg, Rehmann 130.
- G. drakenbergensis* Sim
 =*G. pulvinata* (Hedw.) Sm.
 Syntypes: Natal, Giant's Castle, Symons s.n. (Sim 9962); Mount aux Sources, Sim 9963; Edwards s.n.
- G. leptotricha* C. Müll.
 =*G. pulvinata* (Hedw.) Sm.
 Isotype: Cape, Somerset East, Mt Boschberg, MacOwan s.n.
- G. senilis* Sim
 =*G. laevigata* (Brid.) Brid.
 Syntypes: Cape, Cookhouse, Sim 9956; Orange Free State, Springfontein, Sim s.n.
- Gymnostomum bewsii* Sim in Dix.
 =*Anoetangium wilmsianum* (C. Müll.) Par.
 Syntypes: Natal, Tugela Gorge, Bews s.n. (Sim 8660); Giant's Castle, Symons s.n. (Sim 8661).
- G. gracile* Dix., *hom illeg.*
 =*G. wageri* Schelpe
 Isotype: Transvaal, Pretoria, Wager 97.
- G. lingulatum* Sim
 =*Didymodon lingulatum* (Sim) Magill
 Holotype: Transvaal, Lechlabla, Houtbosch, Rehmann 437.
- Gyroweisia amplexicaulis* Sim
 =*Husnotiella latifolia* (Dix.) Zander & Magill
 Holotype: Natal, Van Reenen, Wager 414.
- G. latifolia* Dix.
 =*Husnotiella latifolia* (Dix.) Zander & Magill
 Isotype: Rhodesia, Victoria Falls, Sim 8931.
- Harrisonia eckloniana* C. Müll.
 =*Rhacocarpus purpurascens* (Brid.) Par.
 Iso-syntype: Cape, Table Mountain, Rehmann 314.
- H. rehmanniana* C. Müll.
 =*Rhacocarpus rehmannianus* (C. Müll.) Wijk & Marg.
 Iso-syntype: Cape, Table Mountain, Rehmann 313.
- Hookeria tristis* C. Müll.
 =*Callicostella tristis* (C. Müll.) Broth.
 Isotype: Natal, Inanda, Rehmann s.n.
- Hymenostomum eurybasis* Dix.
 Iso-syntypes: Rhodesia, Matopos, Eyles 940, 941; Hellet's Concession, Magude, Sim 8989.
- H. opacum* Wager
 =*Hyophila zeyheri* (Hampe) Jaeg.
 Holotype: Natal, Van Reenen, Wager s.n.
- Hyophila basutensis* Sim
 Holotypes: Cape, Rhenosterberg, McLea s.n. (Rehmann 458).
- H. erosa* Sim
 =*Oreoweisia erosa* (C. Müll.) Kindb.
 Holotype: Natal, Muller's Farm, Drakensberg, McLea s.n. (Rehmann 472).
- Isopterygium brachycarpum* Dix.
 =*Ectropothecium brachycarpum* (Dix.) Magill
 Iso-syntypes: Cape, Knysna, Wager 512; Transvaal, Rietfontein, Wager 234.
- I. punctulatum* Broth. & Wag.
 Isotype: Transvaal, near Rustenburg, Wager s.n.
- I. taylorii* Sim
 Holotype: Cape, Wilderness, Taylor s.n. (Sim 10287).
- Leptotrichum brachypodum* C. Müll.
 =*Ditrichum brachypodum* (C. Müll.) Broth.
 Isotype: Orange Free State, Kadziberg, Rehmann 86.
- Leucobryum gueinzii* C. Müll.
 Iso-syntype: Cape, Montagu Pass, Rehmann 74.
- L. perfalcatum* Sim, *nom. illeg.*
 =*L. rehmannii* C. Müll.
 Holotype: Cape, mountains near Esternek, Knysna, Rehmann 75.
- L. rehmannii* C. Müll.
 Isotype: Cape, mountains near Esternek, Knysna, Rehmann 75.
- Lindbergia haplocladioides* Dix.
 Isotype: Natal, Rydal Mount, Wager 29.
- L. viridis* Dix.
 Isotype: Transvaal, Kaapsche Hoop, Wager 310.
- Macromitrium confusum* Mitt.
 =*Macrocoma lycopodioides* (Schwaegr.) Vitt
 Iso-syntypes: Cape, Table Mountain, Rehmann 165b, 166; Claremont, Rehmann 162; Camps Bay, Rehmann 159.
- M. schlotheimiaeforme* Par.
 Isotype: Cape, Devils Peak, Rehmann 151.
- Meteorium rehmannii* C. Müll.
 =*Squamidium biforme* (Hampe) Broth.
 Iso-syntype: Cape, Montagu Pass, Rehmann 323.
- Microthamnium cavifolium* Dix.
 =*Mittenothamnium cavifolium* (Dix.) Wijk & Marg.
 Syntypes: Natal, Inanda, Rehmann 368; Inanda, Wood s.n. (Rehmann 654); Pietermaritzburg, Wager s.n.
- Microthamnium ctenidioides* Dix.
 =*Mittenothamnium ctenidioides* (Dix.) Schelpe
 Isotype: Cape, near Hogsback, Henderson & Henderson 220.
- Mielichhoferia subnuda* Sim
 Syntypes: Natal, Mooi River, Sim 10217, 10197; Goodoo, Wager 788; Bergville, Wager 715; Ladysmith, Wager 686.
- Nanobryum drummondii* Dix.
 =*N. gladiolus* (Mitt.) Bizot
 Iso-syntype: Cape, Port St Johns, Wager 955.
- Neckera pseudocrispa* C. Müll.
 =*Calyptothecium acutifolium* (Brid.) Broth.
 Isotype: Natal, Van Reenen's Pass, Rehmann 328.
- Oedipodium australe* Wag. & Dix.
 =*Oedipodiella australis* (Wag. & Dix.) Dix.
 Iso-syntypes: Natal, near sea, Wager 3; Cape, Pirie Forest, King William's Town, Wager 823.
- Orthotrichum macleai* Sim
 Holotype: Cape, Graaff-Reinet, McLea s.n. (Rehmann 514).
- O. mirum* Lewinsky
 Holotype: Natal, Scheepers's Nek, Sim 10104.
- O. piliferum* Sim.
 =*O. glaucum* Spreng.
 Lectotype: Cape, Uitenhage, Sim 9001; Isotypes: Eastern Cape, McLea s.n. (Rehmann 516); King William's Town, Sim 7053; Jager's Drift, Sim 10099.
- O. transvaaliense* Rehm. ex Sim
 Holotype: Transvaal, Houtbosch, Rehmann 517.
- Oxyrrhynchium confervoideum* Sim
 Holotype: Natal, Maritzburg, Sim 10278B.
- O. subasperum* Sim
 Syntype: Zululand, Mtunzini, Edwards s.n.
- Philonotis afrocapillaris* Dix. ex Sim
 Isotype: Cape, Wilderness, Taylor s.n. (Sim 10153).
- P. laeviuscula* Dix.
 Isotype: Rhodesia, Umtali, Teague 253.
- Physomitrium succuleatum* Wag. & Wright
 Isotype: South Africa, Wager s.n.
- Plagiothecium hendersonii* Dix.
 =*Entodon dregeanus* (Hornsch.) C. Müll.
 Iso-syntypes: Cape, Hogsback, D. Henderson 366, 365.
- P. membranosulum* C. Müll.
 Isotype: Cape, Table Mountain, Rehmann 389.
- P. rhynchostegioides* C. Müll.
 Iso-syntype: Cape, Hex River Mountains, Rehmann 396.
- P. selaginelloides* C. Müll.
 =*P. membranosulum* C. Müll.
 Iso-syntype: Cape, mountains near Rondebosch, Rehmann 390.
- Platygyrium afrum* C. Müll.
 =*Hypnum cupressiforme* var. *capense* Fleisch.
 Isotype: Cape, prope Rondebosch, Rehmann s.n.
- Polytrichum flexicaule* C. Müll.
 =*P. commune* Hedw.
 Iso-syntype: Cape, near Esternek, Rehmann 275.
- P. natalense* Sim.
 Syntypes: Natal, Upper Bushman's River, Sim 8671; Mount aux Sources, Edwards s.n. (Sim 9696).
- P. trichodes* C. Müll.
 =*P. commune* Hedw.
 Isotype: Natal, Inezanga, Rehmann 277.
- Porothamnium woodii* Sim
 =*Stereophyllum woodii* (Sim) Magill
 Isotype: Natal, Wood 285.
- Porotrichum natalense* C. Müll.
 =*Porothamnium natalense* (C. Müll.) Fleisch.
 Isotype: Natal, Inanda, Rehmann 334.
- P. pennaeforme* C. Müll.
 =*Porothamnium pennaefrondeum* (C. Müll.) Card.
 Iso-syntype: Cape, mountains near Blanco, Rehmann s.n.
- Pottia afrophaea* C. Müll.
 =*Hyophila afrophaea* (C. Müll.) Warnst.
 Isotype: Orange Free State, Bethlehem, Rehmann s.n.
- P. subplanomarginata* Dix.
 Isotype: Cape, Stellenbosch, Wager 671.
- Pseudoleskea macowaniana* C. Müll.
 =*P. leskeoides* (Par.) C. Müll.
 Isotype: Cape, Somerset East, Mt Boschberg, MacOwan 1877.
- Psilopilum afrolaevigatum* Dix.
 Isotype: Natal, Rosetta, Sim 8068.
- P. wageri* Broth. in Dix.
 Isotype: Natal, Rydal Mount, Wager 45.

- Pterygoneurum macleianum* Warnst.
Isotype: Cape, Graaff Reinet, *McLea* s.n. (*Rehmann* 461).
- Ptychomitriopsis africana* Dix.
Isotype: Transvaal, Soutpansberg, Lake Funduzi, *Wager* 1122.
- Ptychomitrium eurybasis* Dix.
Iso-syntypes: Rhodesia, Matopos, *Sim* 8851; Zimbabwe, *Sim* 8808; Macheke, *Eyles* 1994.
- Racomitrium drakensbergense* Sim
= *R. crispulum* (*Hook. f. & Wils.*) Dix.
Holotype: Natal, Giant's Castle, *Symons* s.n. (*Sim* 8697).
- Rhapidorrhynchium zuluense* Sim
= *Sematophyllum zuluense* (*Sim*) *Magill*
Holotype: Zululand, Ngoye Forest, *Sim* 10285.
- Rhynchostegium afrostrigosum* C. Müll.
= *Rhynchostegiella zeyheri* (C. Müll.) *Broth.*
Isotype: Cape, Cape Town, *Rehmann* 364.
- Schweitschkea rehmannii* C. Müll.
= *Helicodontium lanceolatum* (*Hampe & C. Müll.*) *Jaeg.*
Iso-syntype: Cape, Blanco, *Rehmann* s.n., 1875.
- Sciaromium capense* Mitt. ex Dix.
Isotype: Cape, near Hogsback, *D., B. & M. Henderson* 213.
- Sematophyllum wageri* *Wright ex Wag.*
Isotype: Natal, *Wager* s.n.
- Semibarbula elongata* Hilp.
= *Barbula zambesii* *Magill*
Iso-syntypes: Rhodesia, Victoria Falls, *Sim* 8895, 8897, 8898.
- Stereophyllum natalense* Sim
Holotype: Zululand, Ngoye Forest, *Sim* 10275.
- Syrhopodon uncinifolius* C. Müll.
Isotype: Cape, Montagu Pass, *Rehmann* 129.
- Thamnum afrum* C. Müll.
= *Porothamnium hildebrandtii* (C. Müll.) *Fleisch.*
Iso-syntype: Natal, Van Reenen's Pass, *Rehmann* 329.
- Thuidium amplexicaule* C. Müll.
= *Haplcladium angustifolium* (*Hampe & C. Müll.*) *Broth.*
Isotype: Natal, Van Reenen's Pass, *Rehmann* 392.
- T. sublaevipes* Dix.
= *T. ramulosum* (*Mitt.*) *Jaeg.*
Iso-syntypes: Cape, Tjumie, *D. Henderson* 358; Transvaal, Kaapsche Hoop, *Wager* 295.
- T. thamnopsis* Sim
= *Rigodium kilimandscharicum* (*Broth.*) *Par.*
Holotype: Transvaal, Mac-Mac, *McLea* s.n. (*Rehmann* 647).
- Timmiella pelindaba* *Magill*
Holotype: Transvaal, Pelindaba, *Bosman* 1607.
- Tortella obtusifolia* Dix.
= *Barbula umtaliensis* *Magill*
Isotype: Rhodesia, Umtali, *Eyles* 1741.
- Tortella opaca* Dix.
= *Weissia opaca* (*Dix.*) *Magill.*
Iso-syntypes: Rhodesia, Victoria Falls, *Sim* 8884, 8890.
- T. petriana* Sim
= *T. humilis* (*Hedw.*) *Jenn.*
Holotype: Natal, Glynn Falls, *Sim* 10063.
- Tortula irregularis* Sim
= *T. hildebrandtii* (C. Müll.) *Broth.*
Holotype: Natal, Edendale Falls, *Sim* 10064.
- Trachyphyllum maximum* Dix.
Isotype: Rhodesia, Makoni, *Nobbs* 1317b.
- Trematodon africanus* *Wag. & Dix.*
Syntypes: Natal, *Wager* s.n.; Transvaal, Tzaneen, *Wager* s.n.
- T. ligulatus* *Rehm. ex Roth.*
= *T. mayottensis* *Besch.*
Isotype: Natal, Oakford, *Rehmann* 22.
- T. pillansii* *Dix. in Sim*
Iso-syntypes: Cape, Platteklip Ravine, *Sim* 9282; Table Mountain, *Sim* 9297; Miller's Point, *Pillans* 4058, 4060.
- Trichostomum afrofontanum* C. Müll.
= *Barbula afrofontana* (C. Müll.) *Broth.*
Isotype: Natal, Van Reenen's Pass, *Rehmann* 82.
- T. atrovirens* C. Müll.
= *Hyophila atrovirens* (C. Müll.) *Broth.*
Isotype: Natal, Van Reenen's Pass, *Rehmann* 119.
- T. cyathiforme* Dix.
= *Hypnodontium dregei* (*Hornsch.*) C. Müll.
Isotype: Rhodesia, Victoria Falls, *Sim* 8934.
- T. rehmannii* Sim
= *T. tortuloides* *Sull. & Lesq.*
Holotype: Transvaal, Pilgrim's Rest, *McLea* s.n. (*Rehmann* 471).
- Triquetrella strictissima* C. Müll.
= *T. tristicha* (C. Müll.) C. Müll.
Isotype: Cape, Wellington, *Rehmann* 144.
- Webera depauperata* Sim
= *Pohlia depauperata* (*Sim*) *Schelpé*
Holotype: Natal, Giant's Castle, *Symons* s.n. (*Sim* 10208).
- W. macleai* Sim, nom. illeg.
= *Pohlia macleai* (*Sim*) *Schelpé*
Holotype: Cape, Rhenosterberg, *McLea* s.n. (*Rehmann* 548).
- W. revoluta* Sim, hom. illeg.
= *Pohlia simii* *Schelpé*
Holotype: Transvaal, Houtbosch, *Rehmann* 566.
- Weissia dieterleniae* *Thér.*
Isotype: Lesotho, Leribe, *Dieterlen* s.n.
- Weisiopsis pulchreitis* Dix.
Isotype: Natal, Royal Natal National Park, *Wager* 739.
- Zygodon africanus* Sim
Holotype: Transvaal, Mac-Mac, *McLea* s.n. (*Rehmann* 497).
- Z. dixonii* Sim
Holotype: Natal, Cathkin Peak, *Sim* 10004.
- Z. leptobolax* C. Müll.
Isotype: Cape, near Rondebosch, *Rehmann* 379 (499, fide *Dixon & Gepp*, 1923).
- Z. runcinatus* C. Müll.
Iso-syntype: Cape, Table Mountain, *Rehmann* 150b.
- Z. strictissima* (*Rehm.*) C. Müll.
= *Triquetrella tristicha* (C. Müll.) C. Müll.
Isotype: Cape, Wellington, *Rehmann* 144.
- Z. transvaaliensis* Sim
= *Z. intermedius* *B.S.G.*
Isotype: Transvaal, Houtbosch, *Rehmann* 500.

UITTREKSEL

'n Kort oorsig van briologiese versamelings en versamelaars in suidelike Afrika lei 'n katalogus in van tipe eksemplare van suidelike Afrika wat in die Nasionale Herbarium te Pretoria gehuisves is. Die tipe-katalogus, alfabeties gerangskik volgens basioniem, sluit korrekte name, tipe status en etiket data in.

REFERENCES

- CROSBY, M. R. & MAGILL, R. E., 1977. *A dictionary of mosses*. St Louis: Missouri Botanical Garden.
- DIXON, H. N., 1920. New and interesting South African mosses. *Trans. R. Soc. S. Afr.* 8: 179-224.
- DIXON, H. N. & GEPP, A., 1923. *Rehmann's South African mosses*. *Kew Bull.* 6: 193-238.
- DIXON, H. N. & WAGER, H. A., 1929. New and noteworthy mosses from South Africa. *Trans. R. Soc. S. Afr.* 18: 247-261.
- MAGILL, R. E. & SCHELPE, E. A., 1979. The bryophytes of southern Africa: An annotated checklist. *Mem. bot. Surv. S. Afr.* 43: 1-39.
- MÜLLER, C., 1899. Contributions ad bryologiam austro-afram. *Hedwigia* 38: 52-155.
- SIM, T. R., 1915. *Check list of the bryophytes of South Africa*. Pietermaritzburg: Royal Society of South Africa.
- SIM, T. R., 1926. The bryophyta of South Africa. *Trans. R. Soc. S. Afr.* 15: 1-475.
- WAGER, H. A., 1917. *A check list of the mosses of South Africa*. Pretoria.

Notes on African plants

VARIOUS AUTHORS

AMARYLLIDACEAE

A NEW SPECIES OF *CYRTANTHUS* FROM BAVIAANSKLOOF, SOUTH-EASTERN CAPE

Cyrtanthus labiatus R. A. Dyer sp. nov., *C. inaequali* O'Brien affinis, foliis latioribus, pedicellis longioribus, perianthii tubo angustiore, lobis minoribus differt.

Bulbus subglobosus plusminusve 35 mm diam. Folia 3-4, synantha, usque 300 mm longa et 20 mm lata basin et apicem versus gradatim contracta, glabra. Pedunculus ± 300 mm longus, cylindricus, ± 10 mm diam. fistulosus, ± 8 -florus, floribus patentibus; spathae 2, ± 40 mm longae, ± 5 mm latae; pedicelli, plusminusve erecti, usque 22 mm longi. Perianthium zygomorphum labiatum, corallinum, 55-60 mm longum; tubus ± 35 -40 mm longus, e basi 2,5 mm diam. sensim 6 mm diam. ampliatus; lobi 4 supra, 2 infra, ± 20 mm longi, exteriores 6 mm interiores 7 mm lati. Filamenta biseriata, ± 15 mm longa. Stylus cum staminibus 4 arcuatus, ad apicem perianthii fere attingens.

TYPE.—Cape, 3324 (Steytlerville), 19 km from Patensie on Cambria Rd (-DA), in Baviaanskloof, fl. 24/1/1979 in cult. Roy Bayliss 5660 (PRE, holo.).

Bulb subglobose, about 35 mm diam., contracted into a short neck, covered with dry membranous brown scales. Leaves 3-4, contemporary with the inflorescence, up to about 300 mm long and 20 mm broad, gradually contracted to apex and base, slightly concave on upper surface, glabrous, slightly glaucous. Peduncle about 300 mm long, cylindric, ± 10 mm diam., hollow, about 8-flowered, with the flowers more or less spreading (in cult.); spathes 2, ± 40 mm long, ± 5 mm broad; pedicels more or less erect, of different lengths, up to about 22 mm long. Ovary cylindric 6-7 mm long. Perianth zygomorphic, labiate, 55-60 mm long, light coral-red; tube about 35 mm long, 2,5 mm at base and evenly expanded to mouth 6 mm diam., very slightly fluted from mouth; lobes 4+2, four upper ones (2 outer, 2 inner) overlapping and forming a hood, 20 mm long, outer 6 mm broad, inner 7 mm broad; two lower ones (1 outer 1 inner), spreading decurved; filaments (4+2) attached more or less in perianth throat, biseriate, somewhat shorter than the perianth; anthers ± 3 mm long when dehiscent. Style becoming slightly longer than the stamens under the hood and decurved from slightly below stigma; stigma subcapitate very slightly 3-grooved (Figs 1 & 2).

As regards the distribution, only the type colony is recorded. The collector, Roy Bayliss, states that the plants grow in complete shade on the vertical face of a road cutting. The face of the rocks of Table Mountain Sandstone conglomerate were covered with *Coccinia quinqueloba* and the *Cyrtanthus* leaves were growing through this. There were many offsets in the clumps, but no flowers at the time of collection. He goes on to say that permanent shade is given by *Ficus capensis* and *Celtis africana*.

The type specimen flowered in a pot in Barbara Jeppe's greenhouse in Johannesburg in January 1979. These conditions would be far different from



FIG. 1.—*Cyrtanthus labiatus*, depicting the holotype from the Baviaanskloof in the south-eastern Cape, cultivated by B. Jeppe in Johannesburg.



FIG. 2.—*Cyrtanthus labiatus* showing the 8-flowered umbel of the holotype; the perianth-lobes have an unusual labiate spread, 4 lobes comprising the upper hood-like portion and 2 lobes comprising the lower lip.

those of plants flowering in the wild and this one must bear in mind when interpreting and comparing *C. labiatus* with related species. The epithet *labiatus* seemed an obvious choice because of the 4 and 2 spread of the perianth lobes simulating the 2-lobed corolla of the Lamiaceae (Labiatae).

R. A. DYER

A NEW COMBINATION IN *GETHYLLIS*

Gethyllis namaquensis (Schonl.) Oberm., comb. nov.

Klingia namaquensis Schonl. in Rec. Albany Mus. 3: 178 (1919). Type: Cape, Namaqualand, without precise locality, *Kling* s.n. (GRA, holo.).

This elusive species was first collected by the Reverend H. Kling of Steinkopf in the Richtersveld, northern Cape, who sent two bulbs to Schonland at the Albany Museum in Grahamstown in 1918. Schonland placed the species in a new monotypic genus *Klingia*, which he named in honour of the collector. He separated the genus from *Gethyllis* on the grounds of the six filaments which are fused at the base and expanded into a wide cup or corona.

The species was again collected in October 1978 near Rosh Pinah in South West Africa/Namibia by

Mr D. S. Hardy (No. 4924). It flowered at the Botanical Research Institute in November 1979 and afforded the author the first opportunity to study live flowers.

The androecium of *Gethyllis* is extremely variable, the stamens doubling or trebling in some species. Wilsenach, in *Plant Life* 21: 82–88 (1965), investigated the idiograms of *Klingia* and *Gethyllis* and found them to be identical, but he did not sink *Klingia* under *Gethyllis*. However, it is clear from the evidence that the two genera are congeneric. *Klingia namaquensis* has, in fact, for some years been known as *Gethyllis namaquensis*, but the combination has not been published. This omission is now rectified.

A. A. OBERMEYER

ASCLEPIADACEAE

A NEW SPECIES OF *HUERNIA* FROM OWAMBO

Huernia owamboensis R. A. Dyer, sp. nov., caulibus 40–50 mm altis, 8–15 mm diam., 4–5-angulatis, corolla ± 10 mm longa 20 mm expansa, rosacea interne papillosa et minute rubro-punctata, tubo campanulato ± 5 mm longo ± 10 mm diam., corona exteriore aequae 10-dentata, distincta.

Planta succulenta basi ramosa; caules erecti, 40–50 mm alti, 8–15 mm diam., glabri, virides, 4–5-angulati, dentibus deltoideis apiculatis. *Pedicelli* ± 12 mm longi. *Sepala* lineari-lanceolata, $\pm 2,5$ mm longa. *Corolla* ± 10 mm longa, 20 mm diam., extus glabra, intus basin versus plana, supra papillosa, incarnata, minute rubro-punctata; tubus campanulatus, ± 5 mm, longus, 10 mm diam.; lobi patentes, \pm triangulares, 5 mm longi, acuti. *Coronae* lobi exteriores aequae 2-dentati (5 \times 2), lobi interiores breviter incumbentes, obtusi. *Pollinia* oblongo-elliptica, 0,25 mm longa.

TYPE.—S.W. Africa, Owamboland, sandveld, March 1974 (Flowered at PRE, April–May 1979) *J. Vahrmeijer* PRE 57730 (holo.).

Stems succulent, densely branched from the base and extending into clumps, 40–50 mm high, 8–15 mm diam., 4–5-angled, green; angles tuberculate with tubercles deltoid, apiculate, ± 2 mm prominent. Flowers produced from near base of young branches (apparently opening in succession). *Pedicels* ± 12 mm long, spreading. *Sepals* linear-lanceolate, $\pm 2,5$ mm long. *Corolla* ± 10 mm long, ± 20 mm diam. from tip to tip of expanded lobes, closely ribbed on outer surface, pale pink within, with minute maroon spots except on lower half of tube; tube narrowly campanulate with nearly parallel sides, ± 5 mm deep, ± 10 mm diam., smooth within basal portion of tube, minutely papillate above and on lobes; lobes spreading, with minute teeth at the sinuses, \pm triangular, ± 5 mm long, acute. *Corona* united at base spreading on corolla into 10 (5 \times 2) equal teeth, maroon, inner lobes adpressed on back of anthers somewhat swollen, obtuse, not extending over top of staminal column, amber-coloured. *Pollinia* 0,25 mm long, elliptic-oblong, with thickened amber margin $\frac{2}{3}$ of its length, with short basal connectives to small winged carrier (Fig. 3).

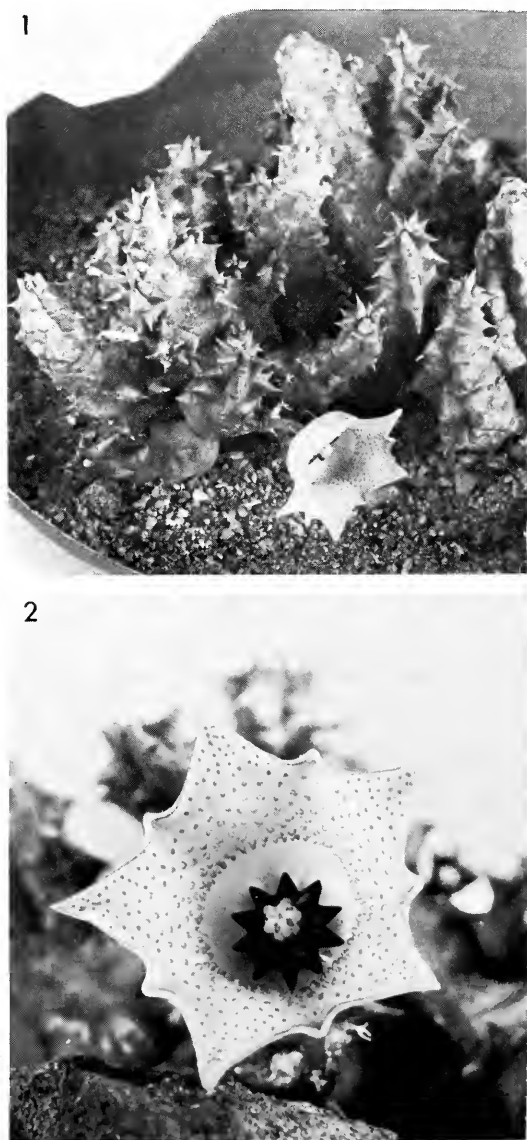


FIG. 3.—*Huernia owamboensis*. 1, plant, natural size; 2, flower, $\times 3$ (*Vahrmeijer* in PRE 57730, holotype). Photo: A Romanowski.

Only one plant was found and collected at the time of discovery. It made slow progress in its new environment at BRI under the care of Mr D. Hardy. When it eventually flowered in April–May 1979, it proved to be undescribed. The small size of the stems

and flowers, their delicate pink colour and the evenly 10-toothed outer corona are distinctive features.

R. A. DYER

LILIACEAE

A NEW SUBTRIBE IN LILIACEAE

Subtribus **Caudibracteatae** Oberm., subtribus nova, *Scilleae* affinis, sed bracteis caudatis differt.

Type genus: *Drimia* Jacq.

In the JI S. Afr. Bot. 43: 265–319 (1977) Jessop revised a group of closely related genera of the tribe Scilleae, all bearing spurred bracts and including some other features as well. These genera, namely *Drimia*, *Urginea*, *Sypharissa*, *Thuranthos*, *Rhadamanthus*, *Litanthus*, *Schizobasis*, *Bowiea* (and *Rhodocodon* from Madagascar) form a natural subtribe and comprise the new subtribe *Caudibracteatae*. It appears to be an ancient group in which the species have become stable and in this it differs from the rest of the *Scilleae* tribe, for instance the genera *Ornithogalum* and *Ledebouria*, where the majority

of the species exhibit variability. In the subtribe *Caudibracteatae* some floral parts, especially the androecium, have become more complex in certain species that otherwise are close to species with the normal type of stamen. In *Thuranthos macranthum* C. H. Wright in Curtis's bot. Mag. 142: t.8680 (1916) for instance, the stamens have evolved into a cage-like body, while in its other characters the species resembles *T. basuticum* (Phill.) Oberm. (p. 139). In *Drimia hyacinthoides* Bak (1874) the lobes of the perianth have remained short and erect, while in other respects it closely resembles other members of *Drimia* with long and recurved lobes.

A. AMELIA OBERMEYER

A NEW SUBGENUS RHADAMANTHOPSIS AND TWO NEW SPECIES OF RHADAMANTHUS

When plants of the two species described below came into flower in the nursery of the Botanical Research Institute, Pretoria, in 1976–77, it was at first uncertain to which genus they belonged.

The two new species differ from typical *Rhadamanthus* only by the locules of the anther, which open loculicidally instead of by apical pores. When Nordenstam revised the genus [Bot. Notiser 123: 155–182 (1970)], he pointed out that in some species, e.g. *R. fasciatus* B. Nord. and *R. albiflorus* B. Nord., the dehiscence is by "apical slits, which eventually proceed down to below the middle of the thecae". It was decided to place the two, possibly more primitive, new species, in a new subgenus *Rhadamantopsis*.

Subgen. **Rhadamantopsis** Oberm., subgenus novum, *Rhadamanthus* subgeneri typico affine, sed thecis antherae longitudinaliter dehiscentibus differt.

Type species: *Rhadamanthus namibensis* Oberm.

Rhadamanthus namibensis Oberm., sp nov., a *R. karoico* Oberm. affinis, sed foliis erectis longioribus et glaucescentibus differt.

Bulbus ovoideus compactus c. 50 mm in diam. tunicis laevis lucidis succulentis; radices crassae. Folia 2–4, hysterantha erecta linearia c. 140–240 mm longa at 10–20 mm lata glauca firma. Racemus simplex ad 0.5 m altus multiflorus; pedunculus erectus teres; bractae caudatae minores caducae; pedicelli sub anthesi decurvati c. 8 mm longi postea erecta 12 mm longi. Perianthium campanulatum c. 9 mm longum pallide lilacinum nitidum; lobi c. 5 mm longi marginibus transparentibus; basi interiori atrovinosi. Stamina 6 brevia inclusa conniventia ad basin perianthii affixa; antherae introrsae thecis loculis longitudinaliter dehiscentibus. Ovarium oblongo-globosum; ovulae c. 8 prope basin affixae; stylus teres; stigma obtusum. Capsula oblonga c. 8 mm longa; semen oblongum, 5 mm longum nigrum nitidum.

TYPE.—S.W. Africa, 2716 (Witpütz): Witpütz-Suid 1 km S.E. of Police Station (–DA), *Giess 13781* (PRE, holo.; WIND).

Bulb c. 50 mm in diam. with wide white to pale mauve, fleshy scales topped by the persistent, transversely striped leaf-bases, which become white,



FIG. 4.—*Rhadamanthus namibensis*. 1, raceme, $\times 0.25$; 2, bulb and peduncle, $\times 0.25$; 3, bulb with leaves, $\times 0.25$. *Giess 13781*. Plate by R. Weber.

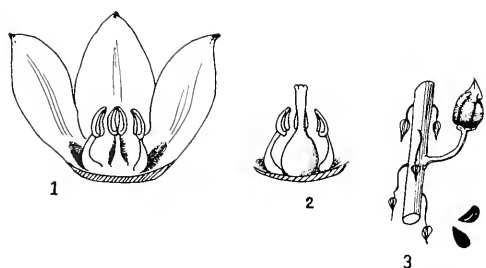


FIG. 5.—*Rhadamanthus namibensis*. 1, 3 perianth lobes and 3 stamens, $\times 3$; 2, gynoecium and 2 stamens, $\times 3$; 3, part of raceme with one capsule, sterile flowers and 2 seeds.

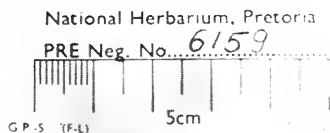


FIG. 6.—*Rhadamanthus karooicus*. Holotype in leaf. Leg. J. van Zanten sub PRE 45560.

crinkled and dry with age. *Roots* many, swollen. *Leaves* hysteranthous, 2–4 per shoot, erect, linear, c. 150–240 mm long and 15–25 mm broad, canaliculate, firm, glaucous, margin smooth, dying back from the tip. *Raceme* simple, up to 0.70 m tall, many-flowered; peduncle firm, terete, c. 0.4 m long, rhachis about equally long; flowers laxly spaced on rhachis; bracts small, varied, tailed, the lower part pale lilac, somewhat fleshy; pedicels c. 8 mm at anthesis, pendulous in bud, erecto-patent in flower and in fruit, lengthening to 12 mm. *Perianth* campanulate, c. 9 mm long, pale mauve, shiny, with a dark base, the lobes c. 5 mm long with transparent margins. *Stamens* short, erect, connivent around ovary, attached to base of perianth; filaments

1.5 mm long; anthers versatile, dorsifixed near base, introrse, apiculate, the locules opening by longitudinal slits. *Ovary* oblong-globose, 3-locular, placentae basal; ovules c. 8, axile; style terete, shallowly 3-grooved, slightly longer than ovary, gradually thickening towards the obtuse apical stigma, shorter than stamens. *Capsule* narrowly ellipsoid, 5–7 mm long, apiculate, loculicidal; the seed semi-discoid to narrowly obovoid, 4–5 mm long, black, shiny. Figs 4 & 5.

At present the plant has only been recorded from the Witputz District in southern South West Africa/Namibia. It was previously collected by De Winter 6304 in the same locality and flowered in the nursery in November 1960. Later two leaves were produced measuring up to 240 mm long and 25 mm wide. The type flowered in October 1977; capsules with ripe seeds were produced in November; the new leaves emerged in January and reached maturity in March 1978.

***Rhadamanthus karooicus* Oberm., spec. nov., a *R. namibensis* affinis, sed minoribus; foliis patentibus minoribus et bulbo ad apicem applanato differt.**

Bulbus oblongus applanatus, c. 30 mm latus tunicae viridae ad apicem asperatae et siccae; radices tenuiores. *Folia* 4–6 hysteranthia patentia c. 6, tenuiter oblonga c. 40 mm longa et 7 mm brevi atroviridia. *Racemus* simplex c. 0.2 m altus; flores c. 30 cernui. *Perianthium* campanulatum inflatum c. 6 mm longum pallide lilacinum nitidum. *Stamina* 6 brevia inclusa conniventes ad basin perianthii affixia; antherae introrsae thecis longitudinaliter dehiscentibus. *Ovarium* oblongo-globosum; ovulae c. 8 prope basin affixae; stylus teres stigma minora. *Capsula* ignota. Figs 6 & 7.



FIG. 7.—*Rhadamanthus karooicus*. Holotype flowering. Leg. J. van Zanten sub PRE 45560.

TYPE.—Cape, 3320 (Montagu): Laingsburg, Farm Keurfontein (—BB), *J. van Zanten sub PRE 45560* (holo.)

Bulbs forming colonies, oblong, broad and flat above, up to c. 30 mm broad; tunics rough and dry at the apex. smooth and green below; roots fairly thin. *Leaves* spreading, up to 6, arranged in 2–3 opposing pairs, spreading, narrowly oblong, up to 40 mm long, 7 mm broad, glabrous, shiny, dark green. *Raceme* simple, c. 0,2 m tall, erect, bearing c. 30 pendulous flowers; bracts small, caudate, membranous, vinaceous, early caducous; pedicels patent, filiform c. 3–8 mm long. *Perianth* campanulate, c. 6 mm long, swollen, pale lilac, shiny

with a faint green keel. *Stamens* 6, included, connivent, attached to base of perianth; anthers c. 1 mm long, orange, dehiscing introrsely by longitudinal slits. *Ovary* ovoid, pale green, style cylindrical, stigma apical, exserted above stamens but included. *Capsule* unknown.

So far this is the only collection that could be studied both in flower and in leaf. It did not set seed.

A specimen collected by *Bayliss* 6327 at Kaboega in the Somerset East District on 1974–01–06 may belong here, but the flowers were described as pale yellow with an indigo streak. Leaves unknown. Noted to be fairly common.

A. AMELIA OBERMEYER

A NEW COMBINATION IN *THURANTHOS*

***Thuranthos basuticum* (Phill.) Oberm., comb. nov.**

Urginea basutica Phill. in Ann. S. Afr. Mus. 16: 306 (1917). Type: Lesotho, *Dieterlen* 854a.

Drimia angustifolia Bak. Fl. Cap. 6: 489 (1897): Jessop in Jl S. Afr. Bot. 43: 273 (1977), non *Drimia angustifolia* Kunth Enum. 4: 340 (1843); the latter appears to be a species of *Ledebouria*.

This species (Fig. 8) closely resembles the other two species *T. macranthum* (Bak.) C. H. Wright (1916) and *T. nocturnale* R. A. Dyer (1964), but the filaments of the stamens are less specialized. They also curve inwards around the style forming a cage-like body, but the upper spreading part remains short.

A. AMELIA OBERMEYER

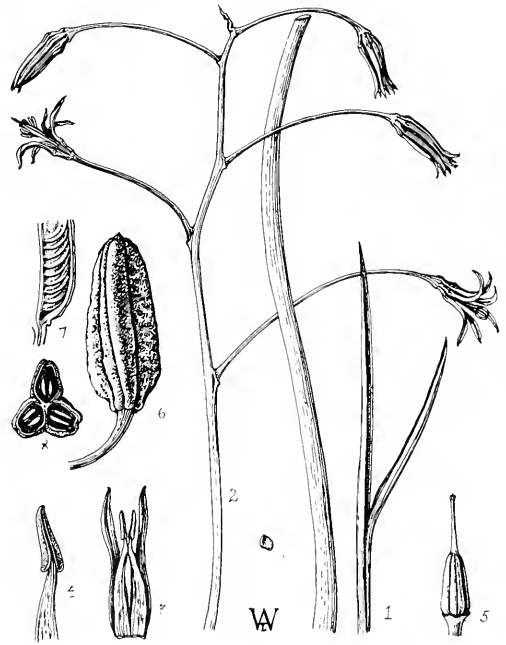


FIG. 8.—*Thuranthos basuticum*. 1, stem and young leaves, $\times 0,6$; 2, flowering stem, $\times 0,06$; 3, filaments and anthers, $\times 1,2$; 4, anther, $\times 3$; 5, ovary and style, $\times 1,2$; 6, fruit, $\times 0,6$; 7, longitudinal section, $\times 0,6$; 8, transverse section, $\times 0,6$; 9, seed, $\times 0,2$. *Strey* 3935. Note: the flower was figured during the morning when the perianth-lobes had started to close; at night they are fully recurved.

THE STATUS OF *URGINEA EPIGEA*

In his revision of the bulbous Liliaceae of South Africa Jessop (1977) sank *Urginea* under *Drimia*. While I agree that some species are better placed with the *Drimia* species of Jacquin, there is a number of others that I prefer to retain in *Urginea*, namely those with small, white, stellate flowers and spreading stamens which Jacquin considered to belong to *Anthericum*. In his revision, Jessop (1977) erred in placing *Urginea epigea* R. A. Dyer as a synonym of *Drimia altissima* (L.f.) Ker Gawl. from the Cape. While the latter is best placed in *Drimia*, Dyer's species is an *Urginea*, closely related to *U. micrantha* (A. Rich.) Solms-Laub. (1867) from tropical east Africa, first described as *Scilla micrantha* A. Rich. in Tent. Fl. Abyss.: 2: 328 (1843).

There is also the taxonomic value of the nature of the bulbs to be considered. In the gregarious species *Urginea epigea*, the bulbs consist of loose scales and grow above ground, whereas apparently the majority of plants identified as *U. micrantha*, have compact hypogeal bulbs and are usually solitary. They are widely distributed in southern to tropical Africa, whereas *U. epigea* has so far only been recorded from the Transvaal and South West Africa. From herbarium sheets with incomplete material and meagre notes one cannot distinguish between these two taxa. This problem requires further study in the field.

A. AMELIA OBERMEYER

THREE SUBSPECIES OF *EUCOMIS AUTUMNALIS**

Within the genus *Eucomis* L'Hérit. there is a group of plants of problematic circumscription. These plants vary in height from 200–500 mm and are a homogeneous green in colour. As a result, the different taxa of this group have never been clearly defined and various names such as *E. autumnalis* (Mill.) Chitt., *E. albomarginata* Barnes, *E. amaryllidifolia* Baker, *E. clavata* Baker, *E. macrophylla* hort., *E. regia* sensu Ait., *E. robusta* Baker and *E. undulata* Ait. have been assigned to them.

In an unpublished monograph of the genus (Reyneke, 1972), it was concluded that the group consisted of only three taxa, all varieties of *E. autumnalis*, namely var. *autumnalis*, var. *amaryllidifolia* and var. *clavata*. In this note the three taxa are published as subspecies, since they occupy fairly distinct geographical areas.

***Eucomis autumnalis* (Mill.) Chitt.** in Royal Hort. Soc. Dict. Gard. 2: 787 (1951). Type: apparently none preserved; neotype: eastern Cape, *Flanagan* 2590 (BOL; NBG, PRE, isoneo.).

Bulb pyriform with dark brown or red-brown membranous tunics. *Leaves* plain green, without a purple colour, usually linear, sometimes lanceolate or ovate; with a distinct midrib; margin undulate; cuticle on margin dentate or crenate. *Inflorescence* a homogeneous green raceme with 50–125 flowers. *Peduncle* cylindrical or clavate. *Scape* 60–200 mm long. *Bracts* linear, shorter than the flowers except for those situated at the apex which are longer. *Coma* with 10–45 sterile bracts, usually pendulous over the inflorescence; bracts oblong, linear or ovate, margin undulate, cuticle on margin undulate and/or dentate. *Pedice* erecto-patent, 3–9 mm long. *Flowers* 50–125; white, yellow-green or light green immediately after anthesis, older flowers green. *Perianth* with 6 segments lanceolate to ovate, persistent. *Stamens* 6, arising from the base of perianth, the filaments triangular-acuminate, their broad bases fused below to form a cup 3–4 mm high. *Gynoeceum* white or yellow-green in young stage, green when older; style cylindrical; stigma simple; ovary with three lateral indentations. *Capsule* trilocular; pericarp membranous, fleshy or hard, opaque with 2 distinct layers. *Flowering period* December to February.

Eucomis autumnalis is usually found in open grassland, but also in sheltered places e.g. in rock crevices, under trees and shrubs and even in swamps.

The morphology of the peduncle, whether clavate or cylindrical, is a distinctive character which does not change in different habitats and is used to distinguish between the three subspecies. A cylindrical scape is characteristic of the subsp. *autumnalis*, while the subsp. *amaryllidifolia* and *clavata* both have clavate scapes (Fig. 9).

Key to the subspecies

- Leaves linear 15–40 mm broad and 130–300 mm long, margin undulate; peduncle clavate; perianth segments 6–10 mm long; capsule papery... (b) subsp. *amaryllidifolia*
- Leaves ovate to lanceolate, seldom linear, 40–130 mm broad, 150–550 mm long, margin undulate; peduncle cylindrical or clavate; perianth segments 10–16 mm long;
- Peduncle clavate; capsule with a hard double-layered pericarp..... (c) subsp. *clavata*
- Peduncle cylindrical; capsule with a thin, sometimes inflated, pericarp..... (a) subsp. *autumnalis*

(a) subsp. *autumnalis*

Fritillaria autumnalis Mill., Gard. Dict. ed. 8 (1768); *Eucomis autumnalis* (Mill.) Chitt. in Royal Hort. Soc. Dict. Gard. 2: 787 (1951).

F. longifolia Hill in Hill's Hort. Kew. ed. 2, 354, t.15 (1769); Vitman, Sum. Pl. 2: 299 (1789–1792).

Eucomis undulata Ait., Hort. Kew. ed. 1, 1: 433 (1789); Don, Hort. Cant. ed. 2, 40 (1796); Willd., Sp. Pl. 2: 93 (1799); Gawler in Curtis's bot. Mag. 27: t.1083 (1808); Willd., Enum. 364 (1809); Ait., Hort. Kew. ed. 2, 146 (1811); Don, Hort. Cant. ed. 6, 86 (1811); Trattinick, Thes. Bot. t.53 (1819); Thunb., Fl. Cap. ed. 2, 317 (1823); Hook., Cat. Pl. R. Bot. Gard. 1: 26 (1825); Spreng., L. Syst. Veg. 2: 76 (1825); Roem. & Schult., Syst. Veg. 7: 622–623 (1829); Kunth, Enum. Pl. 4: 302 (1843); Baker in J. Linn. Soc. (Bot.) 13: 225 (1873); Nicholson, Illus. Dict. Gard. 1: 538 (1885); Engler & Prantl, Pflanzenfam. 2: 67, fig. 47 (1888); Bak. in Fl. Cap. 6: 476–477 (1897); Engler & Drude, Veg. der Erde, 2: 301, fig. 203 (1908); Pole Evans in Flower. Pl. S. Afr. 6: t.220 (1926); Grey, Hardy Bulbs 3: 236 (1938); Batten & Bokelmann, Wild Flow. E. Cape Prov. 12 (1966); Gledhill, East Cape Wild Fl. 72 (1969). *Ornithogalum undulatum* (Ait.) Thunb., Prodr. 1, 62 (1794). *Basilaea undulata* (Ait.) Mirb., Hist. Nat. Pl. 8: 339 (1802–1806). Type: specimen in BM.

E. regia sensu auct. sequent.: Ait., Hort. Kew. 1: 433 (1789); Soland. in Salisb. Prodr. 218 (1796), as *Eucomia regia*; Don, Hort. Cant. ed. 2, 40 (1796); Willd., Sp. Pl. 2: 93 (1799); Red., Liliac. 4: t.175 (1807); Ait., Hort. Kew. ed. 2, 2: 245 (1811); Roem. & Schult., Syst. Veg. 7: 623 (1829); Kunth, Enum. Pl. 4: 302 (1843); non L'Héritier. *Basilaea regia* sensu Mirb., Hist. Nat. Pl. 8: 339 (1802–1806).

Basilaea coronata Lam., Encycl. 1: 382 (1789); Lam., Encycl. 1: 590 (1810); Poir., Encycl. suppl. 1, 590 (1810–1811); Lam., Tabl. Encycl. t.239, fig. 2 (1823).

Eucomis clavata sensu Van der Spuy, Die Groot Veld-blommeboek 175 (1971), non Baker.

Bulb pyriform. *Leaves* linear to ovate, 60–130 mm broad and 150–550 mm long, margin undulate. *Inflorescence* 40–55 mm in diameter with 70–110 compactly arranged flowers. *Peduncle* cylindrical, sometimes slightly clavate, 60–200 (300) mm long. *Scape* 60–200 mm long. *Coma* 70–150 mm in diameter, 10–45 bracts; bracts oblong, 30–70 mm long and 20–40 mm broad and 4–5 mm in diameter. *Perianth segments* 10–13 mm long. *Capsule* with membranous pericarp. Figs 9 & 10.

Subsp. *autumnalis* usually grows as single plants in open grassland, on mountain slopes and forest margins of Malawi, Rhodesia, northern Transvaal and the eastern Cape.

MALAWI.—1234 (Kota Kota): Kota Kota (–CC), Benson 89 (PRE).

RHODESIA.—1832 (Umtali): Inyanga (–BA), Juliesdale, Rutherford-Smith 505 (PRE), World's View (–BA), Plowes 2680 (PRE), 1932 (Melsetter): Umtali, Vumba Mountain (–BA), Obermeyer 2138 (PRE), Castle Beacon (–BA), Farrar 4041 (PRE), Plowes 2240 (PRE).

TRANSSVAAL.—2330 (Tzaneen): Duiwelskloof (–CA), Westfalia Estate, Scheepers 297 (PRE), 2427 (Thabazimbi): Kransberg (–BC), farm Groothoek, Codd 6314 (PRE), 2529 (Witbank): Loskop Dam (–AD), Theron 1769 (PRE & PRU).

CAPE.—3024 (De Aar): Hondebaai (–BC), "Horses Grave", Burchell 2701 (K), 3029 (Kokstad): Cedarville (–AC), Msonyani, Bandert 111 (GRA), 3224 (Graaff-Reinet): Sneeuberg (–AA), Burke, s.n. (K), 3225 (Somerset East): Cradock Bergkwaag Park (–AB), Muller 660 (PRE), 3227 (Stutterheim): Moordenaarskop (–BD) near Komga, Flanagan 2590 (BOL, NBG & PRE), 3325 (Port Elizabeth): Uitenhage (–CD), Ecklon & Zeyher 102 (K).

No specimen was apparently preserved at the time of the original description of this plant, which was grown in England by Miller from seeds which were sent to him from the Cape of Good Hope therefore, in the absence of a figure, a neotype, *Flanagan* 2590, is selected.

Within subsp. *autumnalis*, originally described from the eastern Cape, two forms may be distinguished, namely plants with a southern distribution

* Part of an M.Sc. thesis submitted to the University of Pretoria.



FIG. 9.—Drawings of 1, *Eucomis autumnalis* subsp. *autumnalis*; 2, subsp. *amaryllidifolia*; 3, subsp. *clavata*.

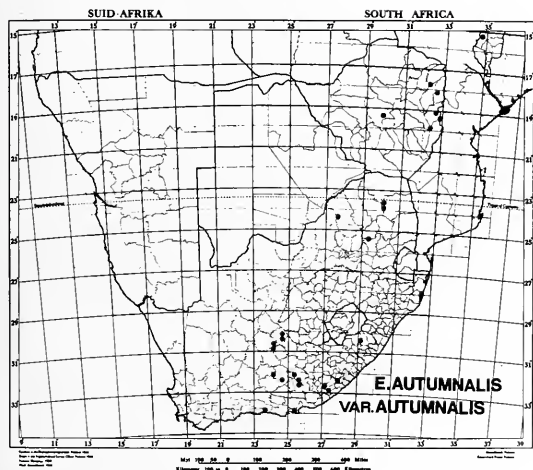


FIG. 10.—The known distribution of *Eucomis autumnalis* subsp. *autumnalis*.

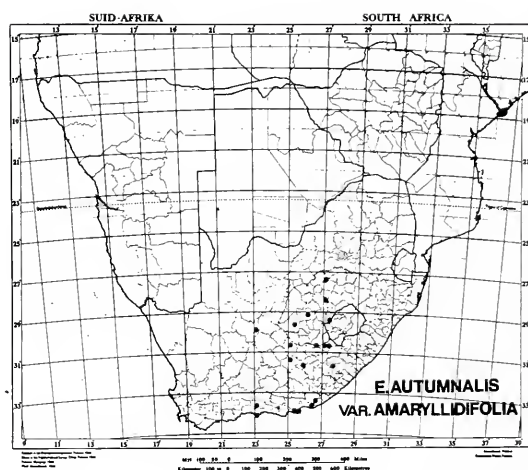


FIG. 11.—The known distribution of *Eucomis autumnalis* subsp. *amaryllidifolia*.

from the eastern Cape showing affinity with subsp. *clavata* in growth and leaf forms, and those with a northern distribution from Malawi, Rhodesia and the northern Transvaal showing affinity with *E. pallidiflora* Bak. except in stature. These two forms could possibly be regarded as distinct subspecies, but there are so many intermediates that such a distinction would be tenuous.

(b) subsp. *amaryllidifolia* (Bak.) Reyneke, stat. nov.

E. amaryllidifolia Bak. in Gard. Chron. 2, 10: 492 (1878); Nicholson, Illus. Dict. Gard. 1: 537 (1885); Bak. in Fl. Cap. 6: 477 (1897); Grey, Hardy Bulbs 3: 232 (1938); Chitt. in Royal Hort. Soc. Dict. Gard. 2: 787 (1951). Type: Eastern Cape Bosberg, MacOwan 1907 (K, holo.; GRA, iso.).

Small plants not more than 350 mm high. *Bulb* pyriform. *Leaves* linear, 130–300 (500) mm long, 15–40 mm broad, margin undulate. *Inflorescence* 25–40 mm diam. with 30–50 compactly arranged flowers. *Peduncle* clavate, 60–130 (230) mm long. *Scape* 30–70 mm long. *Coma* with 13–20 bracts; bracts lanceolate, 24–80 mm long, 20–35 mm diam. *Pedicel* 2–5 mm long. *Perianth* segments 6–8 mm long, 4 mm diam. *Gynoecium* with yellow ovary and white style just after anthesis. *Capsule* with transparent membranous pericarp which is often slightly inflated. Figs 9 & 11.

Subsp. *amaryllidifolia* usually grows in groups between rocks on mountain slopes of the western Orange Free State and eastern Cape Province.

O.F.S.—2727 (Kroonstad): Valsrivier (–AC), Pont 415 (PRE). 2827 (Senekal): “Bell’s Pass” (–AC) Reyneke 318 (PRU). 2925 (Jagersfontein): Fauresmith, koppie in southern part of Botanical Reserve (–CB), Verdoorn s.n., 2209 (PRE), Reyneke 107 (PRU). 2927 (Maseru): Kommissiepoort (–AD), Tylden s.n. (NBG).

CAPE.—2823 (Griekwastad): Griekwastad (–CC), Karreefontein, Wilman 2147 (GRA). 3026 (Aliwal North): Aliwal North (–DA), Elandshoek, Bolus 270 (BOL). 3125 (Steynsburg): Grootfontein College of Agriculture (–AC), Theron 1057 (PRE), Hofmeyer (–DB), False Karoo, Acocks 16336 (PRE). 3323 (Willowmore): Uniondale Poort (–CA), Acocks 20325 (PRE). 3326 (Grahamstown): Grahamstown (–BC), Cherry 941 (GRA), Dyer 420 (GRA & PRE).

(c) subsp. *clavata* (Bak.) Reyneke, stat. nov.

E. clavata Bak. in Saunders’s Ref. Bot. 4: t.238 (1871); Lucas & Pike, Wild Flow. Witwatersrand (1971). Type: Orange Free State, Cooper 1196 (K, holo.; NU, iso.).

E. regia sensu auct. sequent: Bak. in J. Linn. Soc. (Bot.) 13: 225 (1873); Bak. in Fl. Cap. 6: 477–478 (1897); Turrill in Gard. Chron. 8: 75 (1921); Grey, Hardy Bulbs 3: 236 (1938); Chitt. in Royal Hort. Soc. Dict. Gard. 2: 787 (1951); Pam in J. Royal Hort. Soc. 69: 164 (1951); non L’Héritier. *E. macrophylla* hort., Bak. in J. Linn. Soc. (Bot.) 13: 225 (1873).

E. robusta Bak. in Fl. Cap. 6: 477 (1897); Grey, Hardy Bulbs 3: 236 (1938); Chitt. in Royal Hort. Soc. Dict. Gard. 2: 787 (1951). Type: Natal near Koenigsberg, cultivated specimen introduced by Danmann & Co. of Naples, 1894 (BOL, holo.).

E. albomarginata Barnes in S.A. Gdn Country Life 20: 115 (1930); Grey, Hardy Bulbs 3: 231 (1938). Type: Orange Free State, Clarens, De Leeuw s.n. sub NBG 1876/26 (BOL; holo.; NBG, iso.).

E. undulata sensu Letty, Wild Flow. Transv. 28 (1962); Trauseld, Wild Flow. Natal Drakensberg 25 (1969).

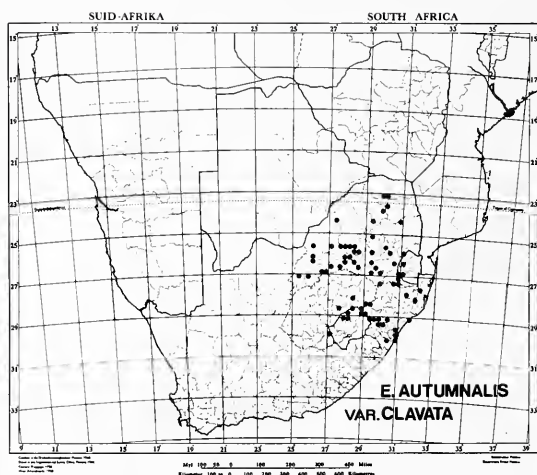


FIG. 12.—The known distribution of *Eucomis autumnalis* subsp. *clavata*.

Bulb dome-shaped. *Leaves* lanceolate to ovate, sometimes linear, 150–450 (600) mm long, 60–130 mm broad, margin undulate; cuticle on leaf-margin dentate. *Inflorescence* 50–70 mm diam., 50–125 flowers which are exceptionally compactly arranged. *Peduncle* mostly clavate, 70–120 (230) mm long. *Scape* 70–130 mm long. *Coma* 130–180 mm diam., pendulous over inflorescence, 15–30 sterile bracts; coma bracts ovate, 50–80 mm long, 30–50 mm diam. *Pedice* 3–8 (10) mm long. *Perianth* segments 12–17 mm long, 5–6 mm diam. *Capsule* with hard opaque pericarp in which two layers can be distinguished. Figs 9 & 12.

Subsp. *clavata* usually grows in groups in open grassland and marshes. Recorded from Botswana, Transvaal, Orange Free State, Swaziland and Natal.

BOTSWANA.—2525 (Mafeking): Lobatsi (—BA), *Watt & Breyer-Brandwijk* 1886 (PRE).

TRANSVAAL.—2429 (Zebediela): Zebediela (—AD), summit of mountain, *Reyneke* 101 (PRU). 2430 (Pilgrim's Rest): Mariëpskop (—BD), *Reyneke* 100 (PRU), Bedford foot-path, *Van der Schijff* 4689, 6254 (PRE & PRU). 2526 (Zeerust): Zeerust (—CA), *Jenkins* 11691 (PRE). 2528 (Pretoria): Pretoria (—CA), Pretoria University Experimental farm, *Codd* 3692 (PRE); 14 miles south east of Pretoria (—CD), *Codd* 6214a (PRE). 2530 (Lydenburg): Belfast Forest Reserve (—CA), *Reyneke* 92 (PRU). 2531 (Komatiport): Louw's Creek (—CC), *Brayshaw* 170 (NU). 2626 (Klerksdorp): Lichtenburg (—AA), *Hesse* 1599 (PRE). 2628 (Johannesburg): Johannesburg (—AA), *Holden* 28053 (PRE). 2630 (Carolina): The Gem (—BC), *Walker* 1212 (PRE). 2730 (Vryheid): near Piet Retief (—BB), *Compton* 22335 (NBG).

O.F.S.—2827 (Senekal): Rosendal (—BD), Rhebokkop, *Goossens* 1883 (PRE). 2828 (Bethlehem): 6 miles south east of Bethlehem (—AB), *Scheepers* 1883 (PRE).

SWAZILAND.—2631 (Mbabane): Utukula rocks (—AC), *Compton* 24782, 24865 (NBG). 2632 (Bela Vista): Lebombo mountains (—CC), *Strey* 4661 (NH & PRE).

NATAL.—2729 (Volksrust): Charlestown (—BD), *Smith* 5755 (PRE). 2730 (Vryheid): Mooihoek (—AC), *Devenish* 403 (PRE); near Grootspuit (—BC), *Strey* 8058 (NH & PRE). 2828 (Bethlehem): Royal Natal National Park, Mont-aux-Sources (—DB), *Pardoe* s.n. (PRE). 2829 (Harrismith): Van Reenen (—AD), *Bews* 616 (NU), Van Reenen's Pass, *Schweickerdt* 952 (PRE); Cathedral Peak Forest Station (—CC), *Killick* 1250, 1264, 1294 (PRE), *Reyneke* 50 (PRU). 2930 (Pietermaritzburg): Rietvlei (—AB), Greenwich Farm, *Fry* 5730 (PRE). 3030 (Port Shepstone): between Ixopo and Umzinto (—AB), *Werdermann & Oberdieck* 1209 (PRE).

LESOTHO.—2828 (Bethlehem): Butha Buthe (—CC), *Jacot Guillarmod* 2140 (RUH), Leribe (—CC), *Phillips* 1227, 549 (NBG). 2927 (Maseru): Mafeteng (—CC), *Watt & Breyer-Brandwijk* 2411 (PRE).

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REFERENCE

REYNEKE, W. F., 1972. 'n Monografiese studie van die genus *Eucomis* L' *Hérit.* in Suid-Afrika. Unpublished M.Sc. thesis, University of Pretoria.

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MYRTACEAE

THE IDENTITY OF *EUGENIA WOODII*

Ever since *Eugenia woodii* Dümmer (1912) was described, some doubt has existed as to whether it is a distinct species. In his original diagnosis Dümmer distinguished *E. woodii* from *E. zuluensis* Dümmer by its broadly elliptic or obovate leaves with the midrib impressed above (prominently raised in *E. zuluensis*) and the hypanthium covered with white appressed hairs. He also noted that the ultimate branchlets were slightly sericeous towards their apices, while the axillary and apical buds were appressedly pubescent.

Engler and Von Brehmer (1917) included *E. woodii* in their enumeration of African Myrtaceae, but did not mention some of the outstanding features of this species. In fact, they described the branches and the hypanthium as being glabrous, a character not found on any of three specimens of the syntype, *Wood* 132, investigated by the present author (Fig. 13).

Examination of the material of *Eugenia* in the National Herbarium, Pretoria and the Natal Herbarium, Durban, revealed that almost all the specimens of *E. woodii* were misidentified. Most material was placed under *E. natalitia* Sond., but

some specimens from the Transvaal were not identified to species. Three specimens in the National Herbarium, however, were correctly identified as *E. woodii* by Dr G. J. H. Amshoff of Wageningen in 1960 or 1961 and have apparently escaped the attention of subsequent workers. Dr Amshoff was obviously aware of the correct identity of *E. woodii*, as she had previously referred to the characteristically 2–3-flowered "pedicels" of this species in one of her papers (Amshoff, 1958).

The confusion of *E. woodii* with *E. natalitia* probably arose because of the superficial resemblance in leaf shape. Because of the undue emphasis placed upon leaf shape, the taxonomic significance of the pubescence and other characters of *E. woodii* was apparently either ignored or treated as trivial in nature. This probably led to the inability to distinguish between the two species, and the subsequent incorporation of *E. woodii* as a synonym under *E. natalitia* by Palmer & Pitman (1973). This concept was taken one step further by White (1977), who also added *E. zuluensis* as a synonym and at the same time reduced *E. natalitia* to the



Fig. 13.—*Eugenia woodii*. Part of the syntype, Wood 132 (BM), showing the densely pubescent hypanthia (A) and characteristically 3-flowered cymules (B).

status of subspecies, viz. *E. capensis* (Eckl. & Zeyh.) Sond. subsp. *natalitia* (Sond.) F. White.

The present study has shown that *E. woodii* is a very distinct species, which is not closely related to *E. natalitia*. The comparative anatomy (Van Wyk, 1978) and external morphology revealed additional distinguishing characters which had hitherto been overlooked. Some of these are now included in Table 1, which will enable one to distinguish most specimens of *E. natalitia* and *E. woodii*.

It must be emphasized that morphological characters in the genus *Eugenia* are extremely variable. Taxonomic conclusions must therefore be based on as many different characters as possible. The most reliable characters that can be used to distinguish between the two species are the nature of the disc in bisexual flowers, the degree of pubescence of the hypanthium, the nature of the seeds and the position of the first-formed periderm in the stem. By using the phloroglucinol/hydrochloric acid test on freehand sections of fresh or rehydrated material, the nature of the periderm can be ascertained quickly and easily.

Although *E. woodii* shows some similarity to *E. zuluensis* Dümmer, *E. albanensis* Sond., *E. zeyheri* Harv. and *E. pusilla* N.E. Br., it seems to be more closely related to the recently described *E. erythrophylla* Strey from southern Natal and Transkei, with which it is sometimes confused. However, *E. erythrophylla* differs from *E. woodii* in its more coriaceous and often larger leaves and the much larger flowers, which are usually shorter pedicellate and not aggregated in 3-flowered cymules. The young leaves of *E. erythrophylla* are often densely whitish pilose on both sides with the upper surface of the lamina

usually becoming glabrous before the lower; the reverse is found in *E. woodii*. The pubescence on the hypanthium of *E. erythrophylla* also tends to be denser and more spreading than that of *E. woodii*.

The following amplified description of *E. woodii* is based on the more abundant material now at hand.

***Eugenia woodii* Dümmer** in Gdnrs' Chron. ser.3, 52: 192 (1912); Engl. & Von Brehmer in Bot. Jb. 54: 333 (1917); Von Breitenbach in Indig. Trees S. Afr. 4: 845 (1965). Syntypes: Natal, without precise locality, Gerrard 1643 (K!); between bushes near Durban, Wood 132 (K!; BM!; PRE!).

Eugenia natalitia sensu Palmer & Pitman in Trees S. Afr. 3: 1669 (1973), pro parte quoad *E. woodii*; sensu Compton in Fl. Swaziland: 396, pro parte quoad Compton 25175.

Eugenia capensis (Eckl. & Zeyh.) Sond. subsp. *natalitia* (Sond.) F. White in Kirkia 10: 402 (1977), pro parte quoad *E. woodii*; sensu Coates Palgrave in Trees S. Afr.: 689, pro parte.

Tree up to 20 m high. *Bark* dark brown to grey or whitish, corky and rough, typically flaking off in irregular pieces. *Branchlets* reddish-brown to brown becoming grey when mature, flattened, sparingly to densely covered with appressed hairs, and glabrescent later; buds densely pubescent; internodes (10–) 20–40 (–55) mm long. *Leaves* decussate, rarely in threes, petiolate, lamina conspicuously bronze or pinkish when young, becoming dark green and shiny above, pale whitish green and dull below, initially densely whitish pilose above, usually sparingly pilose to glabrous beneath, soon becoming glabrous with age, usually elliptic to broadly elliptic or obovate to broadly obovate, 35–90 mm long, 20–60 mm wide, with apex bluntly or obtusely cuspidate, tapering from about the middle into the petiole, coriaceous, with revolute margin in dried and fresh leaves; venation pinnately net veined, midrib in dried leaves deeply concave above, strongly elevated below, concave above and prominently elevated below in fresh leaves; primary lateral veins alternate or opposite, (6–) 8–12 (–14) pairs, spreading, raised on both sides in dried leaves, slightly raised or flat on both sides in fresh leaves, fused into a longitudinal lobed marginal vein about 1–4 mm from the margin of the lamina; tertiary veins slightly raised on both sides in dried leaves, obscure in fresh ones; petiole (4–) 5–8 (–10) mm long, ventrally canaliculate and sometimes sparingly covered with appressed hairs. *Inflorescences* rarely short 2–4-flowered racemes mainly on the older wood, flowers usually solitary or in 3-flowered cymules in the axils of bracts or leaves on the first few nodes of the new seasons growth. *Staminate flowers* usually with pedicels (3–) 8–15 (–20) mm long; bracteoles 2, attached at the base of the hypanthium, often absent in the lateral flowers of a 3-flowered cymule, about as long as the hypanthium, c. 0.4–0.8 mm wide, lanceolate, acute, usually densely appressed pubescent, eglandular or with 1–4 glands. *Sepals* 4, subrotund with the apices tending to be acute, 2 large, c. 1.5–2 mm long, c. 2 mm wide, 2 small, c. 1–1.5 mm long, c. 1.5 mm wide, outer surface sparingly to densely pubescent and sparingly gland-dotted, margins usually ciliate. *Petals* 4, very rarely 5, white to greenish-white or pinkish, usually elliptic, sometimes oblong or more or less oval, c. 4–6 mm long, c. 3–4 mm wide, margins usually ciliate, eglandular or with a few obscure glands. *Disc* with a central depression, surface even, fleshy and usually densely pubescent. *Stamens* usually 20–30, arising from the disc; filaments of various lengths, c. 3–6 mm long; anthers 2-theccous, 1×0.75 mm, all fertile. *Hypanthium* more or less

TABLE 1.—Organographic and anatomical differences between *Eugenia woodii* and *E. natalitia*. Characters regarded as most significant are marked with an asterisk

Character	<i>E. woodii</i>	<i>E. natalitia</i>
Bark	Rough and corky, usually flaking in irregular pieces	Usually smooth or slightly rough, sometimes lightly flaking
Pubescence of apical and axillary buds	Densely pubescent	Very sparingly pubescent or glabrous
Pubescence of the lamina in young leaves	Densely pubescent above, sparingly pubescent and soon becoming glabrous beneath	More or less glabrous on both surfaces
Nature of the abaxial lamina surface in mature leaves	Dull whitish-green; secretory cavities usually obscure	Dull green; usually conspicuously glandular punctate
Inflorescences	Flowers usually solitary or in 3-flowered cymes, rarely in racemes	Flowers usually in short racemes (often fasciculate) or solitary, very rarely in cymes
Shape, length and surface of the bracteoles	Lanceolate, acute, c. as long as the hypanthium, densely pubescent	Deltoid, concave, c. $\frac{1}{4}$ – $\frac{1}{2}$ the length of the hypanthium, sparingly pubescent or glabrous
*Surface of the hypanthium	Densely covered with whitish appressed hairs	Glabrous
Nature of the sepals	Usually more or less acute, slightly concave; margins usually ciliate	Rounded, prominently concave; margins usually smooth or with a few scattered hairs
Nature of the petals	White or pinkish, eglandular or with a few obscure secretory cavities; margins ciliate	White, conspicuously dotted with large secretory cavities; margins smooth or with a few scattered hairs
*Nature of the disc in bisexual flowers	Convex, densely pubescent between the stamens	Plane, sparingly pubescent between stamens
Number of stamens in bisexual flowers	Usually 10–20	Usually 30–50
Fruits	Red; flesh cream-coloured	Usually purple, sometimes red; flesh thinner and white
*Seeds	More or less globose; testa thick and woody (c. 1 mm); embryo apparently eglandular	More or less reniform to subreniform; testa thin (c. 0.25 mm) and membranous; embryo conspicuously glandular punctate
*Position of the first-formed periderm in the stem	Subepidermally in the cortex	Deeply seated in the primary external phloem to the inside of the extraxillary ring of fibres

obconical, c. 1–2 mm long, densely appressed pubescent. *Ovary* aborted; style rudimentary, sometimes split into two, c. 0.5–1 mm long or absent; stigma absent. *Bisexual flowers* with the pedicels, bracteoles, *sepals* and *petals* as in staminate flowers. *Disc* convex with an even surface, fleshy, usually densely pubescent. *Stamens* usually 10–20, resembling those of the staminate flowers. *Hypanthium* obconical, c. 2 mm long, covered with whitish appressed hairs. *Ovary* fused to the lower part of the hypanthium, 2-locular; ovules usually 2 per locule, 1 or 2 developing; style filiform, terete, glabrous or with a few scattered hairs, c. 4–6 mm long; stigma small, somewhat capitate, covered with small papillae. *Fruit* a fleshy berry, at first yellow, becoming bright red when ripe, obovoid to subglobose, c. 15–25 mm diam., glabrescent with persistent calyx lobes at the apex; flesh of pericarp reported to be cream-coloured. *Seed* globose with a smooth surface; testa woody and tough with a fibrous texture, c. 1 mm thick, brownish; embryo with cotyledons partly fused, apparently eglandular but sometimes with a few obscure glands mainly associated with the radicular protuberance. Fig. 14.

E. woodii occurs as a tree in forest and associated woodland in Natal, Transvaal and Swaziland probably extending into Mozambique. It is locally common in

some localities, especially the forests of the north and north-eastern Transvaal where it often occurs in association with *E. natalitia* Sond. Flowering takes place mainly from September to November.

For the present I am referring to *E. woodii* all the specimens (mainly from PRE and PRU) cited below. Unfortunately most collections are without bisexual flowers or fruits, therefore these identifications must be considered as tentative. There are indications that a thorough study of the fresh fruits of *E. woodii* may eventually prove that the species can be separated into several infraspecific taxa.

TRANSVAAL.—2229 (Waterpoort); Wylliespoort (–DD), *Van Wyk* 903; 904; 905 (PRU). 2230 (Messina): Entabeni (–CC), *Poynton s.n. sub PRE 50706* (PRE); Tate Vondo Forest Reserve (–CD), *Hemm* 22 (PRE). 2329 (Pietersburg): Lejuma near Louis Trichardt (–AB), *De Winter* 6003A; Hanglip Forest Reserve (–BB), *Poynton s.n. sub PRE 50630* (PRE), *Van Wyk* 907 (PRU). 2430 (Pilgrim's Rest): 10 km from the Ofcolaco-Trichardtsdal junction on the road to the Downs (–AA), *Van Wyk* 2168 (PRU); Cyprus Farm (–AB), *Renny* 182; 226; 245 (PRE); *Van Wyk* 2165 (PRU); Welgevonden Forest Reserve (–DB), *Loock s.n. sub PRE 57403* (PRE); Blydepoort Nature Reserve (–DB), *Botha* 1972 (PRU; PUC); *Van Wyk* 825 (PRU); Mariepskop, near Reitz's grave (–DB), *Van der Schijff* 6013 (PRE; PRU); Mariepskop, Blyde River picnic spot (–DB), *Van der Schijff* 6091, 6394A (PRE; PRU); *Van Wyk* 2146; 2150 (PRU); Lothian Forest near Bushbuck Ridge (–DD), *Forest Officer* 35 (PRE). Grid. ref. unknown: Soutpansberg Mountains, *Poynton s.n. sub PRE 50653* (PRE).

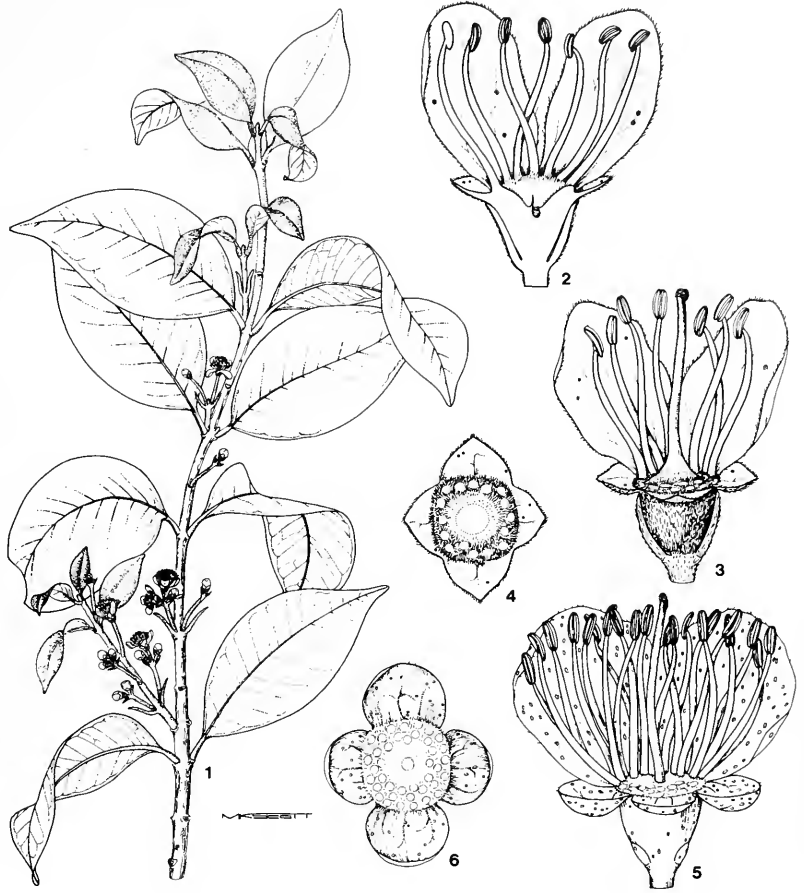


FIG. 14.—*Eugenia woodii* compared with *E. natalitia*. *E. woodii*: 1, leafy twig with male flowers, $\times 0.5$; 2, longitudinal section of male flower, $\times 6$; 3, bisexual flower with front petals and stamens removed, $\times 6$; 4, disc with calyx (other floral parts removed), $\times 6$. *E. natalitia*: 5, bisexual flower with front petals and stamens removed, $\times 6$; 6, disc with calyx (other floral parts removed), $\times 6$. (1 from Renny 245; 2 from Van Wyk 2146; 3 and 4 from Van Wyk 2416; 5 and 6 from Van Wyk 1119).

SWAZILAND.—2631 (Mbabane): Mbuluzi Falls (–AC), Compton 25175 (PRE); 4 km NE of Mbabane (–AC), Kemp 1048 (PRE); c. 1.5 km NW of Mbabane (–AC), Miller S/138 (PRE); Sibanyone Hill (–CA), Miller S/264 (PRE).

NATAL.—2632 (Bela Vista): Amanzimnyana, 10 km E of Maputa (–DD), De Winter & Vahrmeyer 8605 (PRE), near Kosi Bay Nature Reserve (–DD), Edwards 2553 (PRE), Kosi River (–DD), Moll & Strey 3833 (PRE); N bank of Nswamanzhi River, near Mhlanga Lake (–DD), Tinley 328 (PRE). 2731 (Louwsburg): Sokosoko Forest (–DC), Gerstner 4909 (PRE). 2732 (Ubombo): Gwalaweni Forest (–AA), Botha & Van Wyk 949; 1122 (PRU); Vahrmeyer & Hardy 1672 (PRE); Sibayi Dune Forest (–BC) Sibayi Project 327 (PRE); Venter 5812 (PRU); Ngoboseleni Lake (–DA), Ross & Moll 5074 (NH: PRE). 2831 (Nkandla): emGangado (–BB), Gerstner 5031 (PRE); Eshowe (–CD), Thode A1237 (NH: PRE). 2832 (Mtubatuba): Mapelan Forest (–AD), Venter 5573 (PRU); Banghazi Lake (–BA), Venter 5700 (PRU); Enseleni Nature Reserve near Richards Bay (–CC), Venter 5913; 5914; 6099 (PRU). 2930 (Pietermaritzburg): near Durban (–DD?), Wood 132 (K; BM; PRE); Westville, Palmiet Nature Reserve (–DD), Ward 8207 (PRE). 2931 (Stanger): King Hamlyn's Farm, Darnall (–AD), Moll 3611; 5503 (NH: PRE). 3030 (Port Shepstone): Isipingo Beach (–BB), Ward 1000 (PRE).

LOCALITY UNKNOWN.—Cultivated plants on the campus of the University of Pretoria, Van Wyk 2416; 2419 (PRU).

Over the whole of its distribution range *E. woodii* shows considerable variation in leaf shape and leaves from more northerly plants are often larger than those from the south. Specimens from open woodland also possess smaller and more coriaceous leaves and tend to be more shrubby than their forest counterparts.

The fruits of *E. woodii* are edible and reported to have a pleasant taste. They are preferred to those of *E. natalitia*, which are less fleshy and have a mealy after-taste.

Common names: iJobe (Sw); umbomvane (Z); 'stawatawane (V). However, some of these names are also recorded for *E. zuluensis* and *E. natalitia*.

REFERENCES

- AMSHOFF, G. J. H., 1958. Notes on Myrtaceae. VII Myrtaceae of French Equatorial Africa. *Acta bot. neerl.* 7: 53–58.
- DÜMMER, R. D., 1912. Eugenis of South Africa. *Gdnrs' Chron.* Ser. 3, 52.
- ENGLER, A. & VON BREHMER, W., 1917. Myrtaceae africanae. *Bot. Jb.* 54: 229–341.
- PALMER, E. & PITMAN, N., 1973. *Trees of Southern Africa* III. Cape Town: A. A. Balkema.
- VAN WYK, A. E., 1978. 'n Taksonomies-anatomiese ondersoek van verteenwoordigers van die genus *Eugenia* L. (Myrtaceae) in Suid-Afrika. Unpublished M.Sc. thesis, Potchefstroom University for C.H.E.
- WHITE, F., 1977. Some new taxa in African Myrtaceae. *Kirkia* 10,2: 401–404.

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VITACEAE

A NEW SPECIES OF *RHOICISSUS* FROM NATAL

Rhoicissus sessilifolia Retief, sp. nov., *R. rhomboidea* (E. Mey. ex Harv.) Planch. affinis, sed foliis sessilibus et petiolulo glabro differt.

Planta scandens caulo verrucato; cirrhis glabris. Folia spiralter disposita, sessilia, glabra, 3-foliolata; foliolis terminalis petiolulatisque distinctis petiolulis 10–20 (27) mm longis, lamina obovata ad elliptica, (35–) 43–70 (–80) mm longa, 19–32 (–40) mm late, apice acuta vel obtusa, base cuneata, margine integro vel 2–3 (aliquando 1) dentato in latero uno vel utrinque; foliolis lateralibus petiolulis brevioribus, petiolulis (1,2–) 2–3,5 (6) mm longis, lamina ovata, 20–35 (–47) mm longa, 12,5–35 mm late, acuminata, base asymmetrica, margine integro vel 2–3 (aliquando 1) dentato in latere uno vel utrinque; pagina inferiore foliolorum omnium venis majoribus prominentibus formentibus venatiorem conspicue reticulatum; acarodomatii interdum in axillis venarum inferarum lateralium. Inflorescentia cyma, folia opposita vel in cirrhis, partibus juvenibus pubescentibus. Calyx cupulatus, Petala 6, glabra, eburnea. Stamina 6, supra ovarium flexa, antheris basifixis, oblongis, 0,5 mm longis. Ovarium in disco immersum; stylo lineare; stigmate simplice, obtuso. Fructus bacca ovoidea, 6–9 mm longus, 8–10 mm latus, ruber juventute, atropurpureus maturitate. Semina globosa c. 5–7 mm longa, 5–6 mm lata, rugosa, sulco longitudinali, latere uno complanato ubi semina binatim.

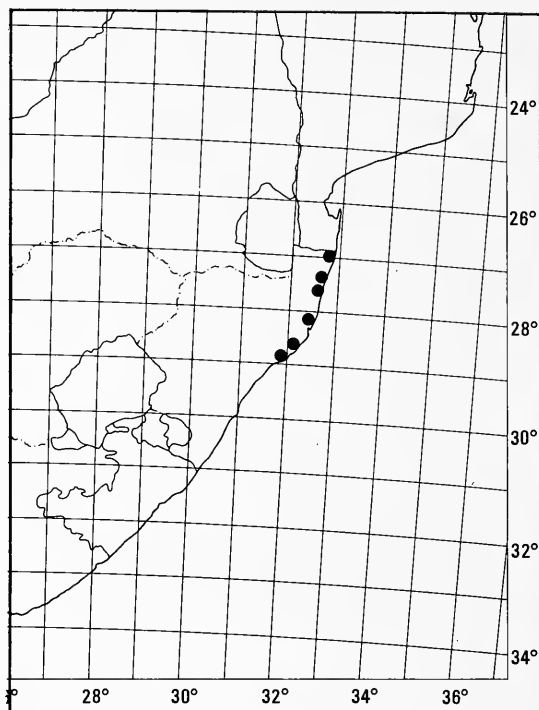


FIG. 16.—Distribution of *Rhoicissus sessilifolia*.

TYPE.—Natal, 2732 (Ubombo): eastern shores of Lake Sibayi (–BC), *Moll & Nel 5619* (PRE, holo.)

Climber with warty stems; tendrils glabrous. Leaves spirally arranged, sessile, glabrous, 3-foliolate; terminal leaflets distinctly petioled, petiolules 10–20 (27) mm long, lamina obovate to elliptic, (35–) 43–70 (–80) mm long, 19–32 (–40) mm broad; lateral leaflets with shorter petiolules, petiolules (1,2) 2–3, 5 (6) mm long, lamina ovate 20–35 (–47) mm long, 12,5–35 mm broad, acuminate, base asymmetrical, margin entire or with 2–3 (sometimes 1) dentations on both sides, under surface of all leaflets with major veins raised to form a conspicuously reticulate venation; acarodomatia sometimes present in axils of lower lateral veins. Inflorescence a cyme, leaf-opposed or on tendrils, young parts hairy. Calyx cup-shaped. Petals 6, glabrous, creamy white. Stamens 6, bending over ovary, anthers basifixed, oblong, 0,5 mm long. Ovary immersed in a disc; style linear; stigma simple, obtuse. Fruit an ovoid berry, 6–9 mm long, 8–10 mm broad, red when young, purplish black when ripe. Seeds globose, c. 5–7 mm long, 5–6 mm broad, rugose, with a longitudinal furrow, one side flattened when seeds in pairs. Fig. 15.

NATAL.—2632 (Bella Vista): coastal dune forest north of Kosi Bay (–DD), *Stephen & Van Graan 1295*. 2732 (Ubombo): Mandozi Forest, Lake Sibayi (–BC), *Vahrmeijer & Hardy 1606*; eastern shores of Lake Sibayi (–BC), *Moll & Nel 5619*; Sordwana Bay (–DA), *Tinley 451*, 2831 (Nkandla): Umlalazi Nature Reserve (–DD), *Moll 4979*; *Guy & Ward 62*. 2382 (Mtubatuba) along Charters Creek, Lake St Lucia (–AB), *De Winter 8742*; Richards Bay (–CA), *Strey 9910*; mesic forests near quarry (village area), Richards Bay (–CC), *Venter 5549*.

R. sessilifolia is endemic to Natal, occurring only in a restricted area (Fig. 16) of coastal dune forest. The first record of the species in the National



FIG. 15.—*Rhoicissus sessilifolia* (Moll & Nel 5619, PRE, holotype).

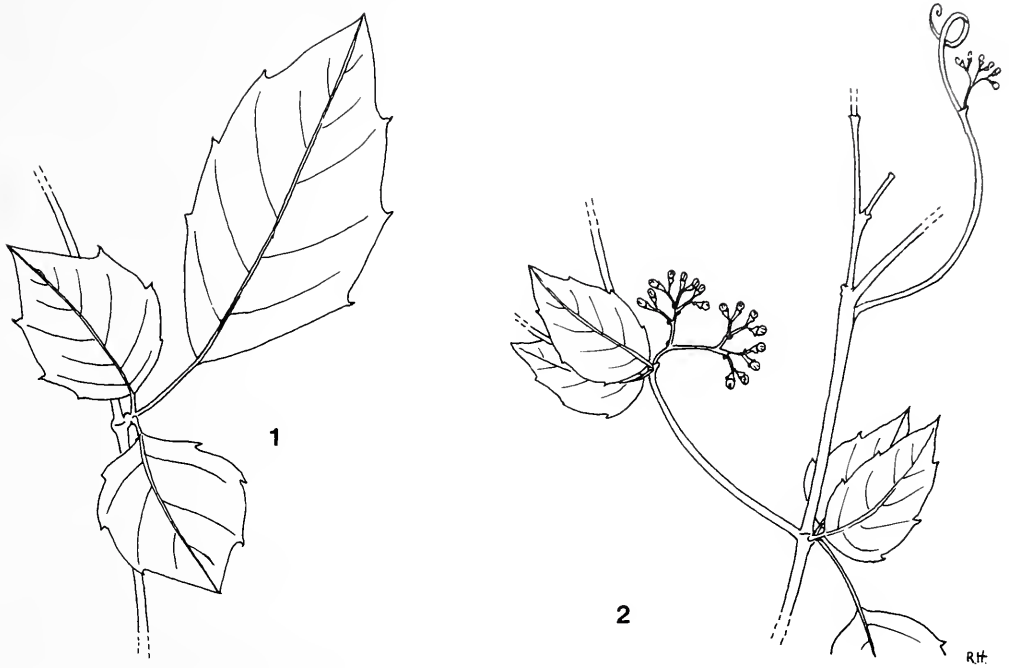


FIG. 17.—*Rhoicissus sessilifolia*, 1, leaf, $\times 1$; 2, part of a branch with an inflorescence on a tendril, $\times 0.5$.

Herbarium was from the Umlalazi Nature Reserve, collected during January 1959 (Guy & Ward 62). For nearly twenty years this remarkable species of *Rhoicissus* has been known, but never correctly assessed until now. All the material cited above has either been identified as *R. rhomboidea* or *R. revoilii* or placed amongst the unnamed specimens. Although *R. rhomboidea* occurs in the distribution area of *R. sessilifolia*, it can be distinguished from the latter species by the distinctive petioles (sometimes up to 35 mm) and long reddish brown hairs on the stems, petioles and peduncles. *R. revoilii* is, in addition a woodland species, often recorded from rocky hillsides.

R. sessilifolia differs from all the other known species of the genus in having sessile compound leaves (Fig. 17). The tendrils of *R. sessilifolia* usually consist of two internodes with an inflorescence often developing at the node. This is also the case in several other species of the genus *Rhoicissus*. According to various authors [see Wild & Drumm. in Fl. Zamb. 2: 493 (1963), Dyer, Gen. 1: 350 (1975)], the genus *Ampelocissus* Planch. differs from *Rhoicissus* in having tendrils which bear inflorescences. The presence or absence of inflorescences on tendrils cannot therefore be used to distinguish between *Ampelocissus* and *Rhoicissus*.

ELIZABETH RETIEF

Encoding the National Herbarium (PRE) for computerised information retrieval

J. W. MORRIS*

ABSTRACT

This paper describes the operation of encoding information from 470 000 extant herbarium labels for accession to a computer data bank with a view to aiding curators and systems analysts who may wish to apply similar procedures in their herbaria. The preparation of the herbarium, encoding procedures used, verification of encoded information, costs and remuneration of encoders are described. A complete list of items encoded and their code equivalents is given. Some of the difficulties faced during the operation are discussed and the success of the project to date is evaluated briefly. Its success is attributed to a bonus incentive scheme and availability of a comprehensive instruction manual.

RÉSUMÉ

ENCODAGE DE L'HERBIER NATIONAL (PRE) POUR EXTRACTION DE L'INFORMATION PAR ORDINATEUR

On décrit ici l'encodage de l'information contenue dans 470 000 étiquettes d'herbier pour leur incorporation à une banque de données d'ordinateur; cette publication vise à aider les conservateurs et analystes qui souhaiteraient appliquer des procédures similaires à leurs herbiers. La description comprend: la préparation de l'herbier, les procédés d'encodage utilisés, la vérification de l'information codée, le coût de l'opération et la rémunération des encodeurs. On donne une liste complète des éléments encodés et de leurs équivalents dans le code. Certaines des difficultés rencontrées en cours d'exécution sont discutées et le succès du projet à ce jour est évalué brièvement. Ce succès est attribué à un plan d'encouragement financier et à la disponibilité d'un manuel d'instructions complet.

INTRODUCTION

One of the most expensive and logistically-complicated parts of the operation to set up a computerised information storage and retrieval system for the National Herbarium was the encoding of the extant 470 000 specimen sheets. While it was acknowledged that without inclusion of these specimens, known below as the backlog, a data bank of new accessions would have limited value, the complete encoding of a herbarium of this size had not previously been attempted (Morris, 1974). In this paper, the procedures developed for the encoding of backlog material are described in detail, as it is considered that these will be of use to all curators of collections and systems analysts contemplating such an operation in future. The benefits being accrued from computerisation are such that it is hoped that other herbaria will follow this lead (see Brenan *et al.*, 1975). Preparation of the herbarium, training of staff for encoding and the development of a remuneration system for the part-time bonus incentive encoding scheme were some of the essential aspects which required attention and are reported here. Another reason for recording these procedures, and the explanations accompanying items and their codes in particular, is that users of the data bank will then know the conventions adopted during coding. Without this knowledge, they may have difficulty formulating their queries for optimum results.

Backlog encoding was one aspect of the development of an integral computer-based system for the retrieval of information from specimen labels, taxonomic data and literature references. The whole system, as it exists at present, is described by Morris & Glen (1978). The part described here deals only with that information recorded by collectors on their labels together with the state of the specimen and its scientific name, including only specimens collected prior to the completion of the project reported here.

THE HERBARIUM AND ITS PREPARATION FOR ENCODING

The National Herbarium is located in four wings of the building housing the headquarters of the Botanical Research Institute in Pretoria, South Africa. Specimens are housed in some 500 cabinets, each with 24 to 36 shelves, and are arranged in the taxonomic sequence of Dyer (1975, 1976). Specimens are filed in blue, heavy paper species covers which are themselves contained in light card, brown genus covers. Type specimens are generally located at the start of a species and are filed in easily-identifiable special folders with red edges. Within a species, specimens are arranged by province and country with the oldest specimen from a province or country at the top and the newest accession at the bottom. Only one province or country is contained in a blue cover and the province or country is written on the outside of the cover. It was decided that all material of indigenous taxa from the Flora of Southern Africa Area (Ross *et al.*, 1977) as well as all African type material and photographs of African type material, when the actual specimen was housed elsewhere, would be encoded. Specimens having labels with fewer than two items of information were not encoded.

A twelve-digit code number, consisting of seven digits for the genus and five digits for the species was developed (Morris & Leistner, 1975; Morris & Glen, 1978). A computer card was punched for each valid combination and four lists of codes, one for each wing of the herbarium, were printed by computer. It was found that there were more than 17 000 Southern African species names included in these master lists. Once these lists had been checked and corrected they were used to number species and genera folders. All name changes accepted by the herbarium from that time were then entered by hand on these lists.

Before encoding commenced in a wing, curatorial assistants paged through the entire collection, checking that all the herbarium sheets within a species cover

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were of the same taxon and that the specimens were correctly identified to genus, species and sub-specific epithet (where appropriate). Where a name could not be assigned, assistants ensured that the unidentified material within a folder was all of the same taxon. The species code number was written on the outside of the species covers and the genus code number was written on the outside of the genus covers.

All herbarium cabinets were numbered by wing and cabinet to facilitate replacement of specimens after encoding.

ENCODING PROCEDURES, VERIFICATION AND REMUNERATION OF ENCODERS

Introduction

Once it had been decided that the backlog housed at PRE would be encoded, the Workstudy Section of the Department of Agricultural Technical Services together with officers from the Botanical Research Institute, investigated ways in which the task could be efficiently, rapidly and cheaply completed (Pieters, 1974). Requirements of the operation were that it was to be carried out within a relatively short period, say two to three years, and that minimal disturbance be caused to routine herbarium curatorial activities. The procedure outlined below was considered superior to the alternative of appointing a smaller number of encoders to work during office hours without a bonus incentive. Direct encoding from specimens onto computer punch cards by means of IBM 029 punches and onto magnetic tape by means of Olivetti key-punch stations were also tried but found to be inefficient, relatively expensive and encoded information was difficult to verify in comparison with encoding onto data sheets and submitting batches of data sheets for punching as a separate task.

Procedures, verification and remuneration

Twenty-eight people were employed to carry out the encoding operation for up to four hours each evening, Mondays to Thursdays. Of these, five teams, each consisting of four encoders and a team checker, completed and checked data sheets, respectively. Two bonus controllers were responsible for vetting a 10 per cent sample of the completed data sheets and a supervisor was responsible for training new encoders, interpreting the encoding instructions written by Morris & Du Toit (1976), when necessary, deciphering unreadable handwriting on labels, translating foreign-language labels and resolving differences of opinion between encoding teams and bonus controllers. Staff consisted of volunteers drawn from the Public Service and no botanical background was expected, except in the case of the supervisor who was expected to have had experience with the project and to have taxonomic knowledge.

Although most of the encoders had no prior botanical background, it was found that, in general, they could be trained within 12 hours (three evenings). Clear, written instructions were a prerequisite for both training and the bonus incentive and penalty scheme and as a result a handbook, which went through a number of editions (Morris & Du Toit, 1976), was compiled. Such a manual also ensured that encoding standards and conventions were maintained throughout the period. Labels in Latin and German were particular problems as they were next most common after English and Afrikaans and most encoders were not familiar with these languages.

Lists of words commonly occurring on labels with their meanings and code equivalents (see below) were drawn up for use by encoders (Tables 1 & 2). These *ad hoc* lists should not be considered as definitive translations (the ablative case of nouns, for example, is often given as the most common case occurring on labels was usually listed) but indicate the use made of such aids by encoders.

Another problem faced by encoders was that of illegible handwriting and obvious copy typing errors. Where encoders could not decipher writing, the supervisor was asked to assist. In some cases, words could not be deciphered and were not encoded.

TABLE 1.—Alphabetical list of Latin terms and their English equivalents and numeric codes. Nouns are given in the case (often ablative) in which they are most often encountered on labels

<i>ad ripam</i>	=on river bank (moisture regime 07)
<i>ad rivulum</i>	=on stream bank (moisture regime 07)
<i>ad viam</i>	=at road (biotic effect 06)
<i>albi/albus</i>	=white (colour)
<i>anno</i>	=year (date of collection)
<i>apertis</i>	=open (not coded except <i>apertis silvae</i> =vegetation 5)
<i>arenosus</i>	=sandy (soil type 02, substrate 1)
<i>argillaris</i>	=white clay (soil type 04, soil colour A 1)
<i>aridulus</i>	=slightly dry soil (substrate 1)
<i>aridus</i>	=dry soil (substrate 1)
<i>campester</i>	=flat area (marsh) (moisture regime 05)
<i>capensis planitie</i>	=Cape Flats (locality)
<i>CBS</i>	= <i>C. B. Esp.</i> (=erance)=Cape of Good Hope (locality)
<i>circa</i>	=about (not coded)
<i>clivus</i>	=slope (not coded)
<i>clivus supra</i>	=upper slopes (not coded)
<i>collibus/collinus</i>	=hill (not coded)
<i>convalle</i>	=river valley (not coded)
<i>corolla</i>	=part of flower (flower colour)
<i>corona</i>	=part of a flower (flower colour)
<i>declivis</i>	=downward slope (not coded)
<i>ericifruteceta</i>	=fynbos (vegetation 8, Veld type 69)
<i>ericetis</i>	=fynbos (vegetation 8, Veld type 69)
<i>flavi</i>	=yellow (colour)
<i>flore</i>	=flower (possibly flower colour)
<i>flumen</i>	=river (moisture regime 08)
<i>fructus/fructificatio</i>	=fruit (possibly fruit colour)
<i>fruticis</i>	=scrub (vegetation 6)
<i>frutex</i>	=shrub (life form 02)
<i>fusci rubi</i>	=dark red (colour)
<i>graminosis</i>	=grass (vegetation 3)
<i>humidus</i>	=damp ground (marsh) (not coded)
<i>lactei</i>	=white (colour)
<i>lapidos(is)</i>	=rocky (substrate 2)
<i>leg.</i>	=collector (collector)
<i>litor(al)ibus</i>	=sea shore (moisture regime 12)
<i>lutei</i>	=yellow (colour)
<i>luteus</i>	=clay (soil type 04, substrate 1)
<i>maris</i>	=sea (moisture regime 12)
<i>maritimus</i>	=sea shore (moisture regime 12)
<i>montanus</i>	=mountain (not coded)
<i>montibus</i>	=mountain (not coded unless part of locality)
<i>montis</i>	=mountain (not coded)
<i>occidentalis</i>	=western (possibly locality)
<i>orientalis</i>	=eastern (possibly locality)
<i>paludibus</i>	=(in) marsh (moisture regime 05)
<i>paludosus</i>	=marshy (moisture regime 05)
<i>Planitie</i>	=flats (possibly locality)
<i>planitie</i>	=flat (slope 1)
<i>pratis</i>	=meadow (vegetation 3)
<i>purpurei</i>	=purple (red) (colour)
<i>ripis</i>	=river bank (moisture regime 07)
<i>rivulus</i>	=stream (moisture regime 08)
<i>rubi</i>	=red (colour)
<i>sabulosus</i>	=marsh (moisture regime 05)
<i>saltosis</i>	=bushy rocky mountain (vegetation 4, substrate 2)
<i>saxosis</i>	=rocky (substrate 2)
<i>silvae</i>	=forest (vegetation 7)
<i>silvis</i>	=forest (vegetation 7)
<i>s.n.</i>	=no collector's number—assign a PRE number
<i>suffrutex</i>	=shrub (life form 02)
<i>Tabularis</i>	=Table (Mountain) (locality)
<i>umbrasis</i>	=shady area (not coded)
<i>virides</i>	=green (colour)

TABLE 2.—Alphabetical list of German terms and their English equivalents and numeric codes

<i>ausdauernd</i> —perennial (annual etc. 4)
<i>Felsen</i> —rocks (substrate 3)
<i>Geröll</i> —gravel (substrate 1, soil type 1)
<i>Glimmerschiefer</i> —mica slate (rocky) (substrate 2)
<i>haeufig</i> —abundant (abundance 7)
<i>Halbstrauch</i> —halfshrub (life form 03)
<i>Kies</i> —gravel (substrate 1, soil type 1)
<i>lachs</i> —salmon pink (colour)
<i>Quelle</i> —fountain (moisture regime 07)
<i>Rinnal</i> —watercourse (moisture regime 10)
<i>rosa</i> —pink (colour)
<i>Senke</i> —depression (moisture regime 03)
<i>Staude</i> —shrub (life form 02)
<i>Sumpf</i> —marsh (moisture regime 05)
<i>Ton</i> —clay (substrate 1, soil type 04)
<i>Tor</i> —gate/door (not coded unless part of locality)
<i>Wiese</i> —grassland (vegetation 3)
<i>zart</i> —soft (not coded)
<i>zwischen</i> —between (not coded unless part of locality)

Encoders were further instructed to correct obvious typographical errors.

Encoders collected specimens from the herbarium cabinets, a shelf of specimens at a time. For each shelf a Daily Production Sheet (Fig. 1) was completed which accompanied the specimens, held in a parcel by means of a rubber band, through the process until the specimens were returned to the cabinet after encoding and checking. As some shelves required more than one evening to encode, provision was made on the Sheet for encoding to cover as many as four evenings. Most items required to be entered on the Sheet do not require explanation. New encoders were allowed 12 hours in which to work at their own speed without being financially penalised for errors and speed. During this period they were considered as 'learners' (see Fig. 1). Where more than one specimen was mounted on a sheet, a coding form for each specimen was completed. Information from all the labels attached to a specimen were used and in cases of contradiction, information from the apparently-oldest label was favoured.

After being encoded, the specimens, together with their encoding forms, were passed to the team checker. The checker was responsible for checking all the encoded information and correcting any discovered errors. No penalty was incurred for errors

discovered and corrected by the team checker. The checker also rubber-stamped each specimen with a small 'ENCODED' stamp.

From the team checker, specimens were submitted to the two bonus controllers. They took a sample selected at random of 10 per cent of the encoding forms and made a careful comparison of the specimens with the completed data sheets. Errors discovered were of two degrees of severity: full errors (being such things as date of collection omitted or province being incorrectly encoded) and minor errors, counting as one fifth of a full error. A list of full errors was drawn up and it was understood that all other errors counted for one fifth of an error. The number of specimens checked (10 and 3 in Fig. 1) as well as the number of errors found ($\frac{1}{5}$ and $\frac{3}{5}$) were recorded on the Daily Production Sheets. These errors were corrected by the bonus controllers. Specimens were returned to the cabinets by the bonus controllers. Daily Production Sheets were collected until the end of the encoding period, which was usually three or four, four-evening weeks.

At the end of each encoding period the production of each encoder and of each team was calculated and a Monthly Team Summary was drawn up (Fig. 2) for each team. For each encoder, the number of specimens encoded and the number of errors found by the bonus controllers was recorded. The norm was the number of specimens expected from the encoder, based on the number of hours worked and the hourly norm. At the termination of encoding the norm was 16 specimens per hour. Initially it was 10 and it was raised gradually by the supervisor in consultation with the bonus controllers so that the average production per cent of all teams remained in the range from 120 to 140. Production and error per cents were calculated according to the formulae given in Fig. 2. Gross bonus per cent was read from a depressive bonus graph (Fig. 3), using the team's total production per cent. The penalty per cent (using Table 3) was subtracted from the gross bonus per cent to give the net bonus per cent for the team. Bonus controllers made use of a table based on the depressive bonus graph instead of the graph itself for greater speed and accuracy. Although production and error per cents were calculated individually, the team average net bonus per cent was used to calculate payment

DAILY PRODUCTION SHEET					
NAME E KING		TEAM 3		NO. 027	
DATE	HOURS WORKED	TOTAL CODED	LEARNER ^x	CABINET NUMBER	SHELF NUMBER
1976.01.19	4	104		30026	4
1976.01.20	1	26			
5		130			

10	$\frac{1}{5}$	0.6
3	$\frac{3}{5}$	
		13

^x If Learner, mark with 'x'.

Initials of
Coder E.K.

Initials of
Checker J.W.M.

FIG. 1.—Example (slightly reduced) of completed Daily Production Sheet.

MONTHLY TEAM SUMMARY

TEAM NUMBER 3 PERIOD 1976.01.19 - 1976.02.13

ENCODER'S NAME	SPECIMENS ENCODED	NORM	PRODUCTION %	NUMBER INSPECTED	ERRORS	ERROR %	GROSS BONUS %	PENALTY %	NET BONUS
B. JONES	443	272	163	44	1,4	3,2			
C. DICK (Mrs)	740	528	140	76	3,4	4,5			
D. JAMES	248	144	172	35	4,4	12,6			
E. KING	1438	768	187	154	6,2	4,0			
TOTALS	2869	1712	168	309	15,4	5,0	48,6	7,0	41,6

PRODUCTION % = (SPECIMENS ENCODED/NORM) x 100
ERROR % = (ERRORS/NUMBER INSPECTED) x 100

FIG. 2.—Example of completed Monthly Team Summary.

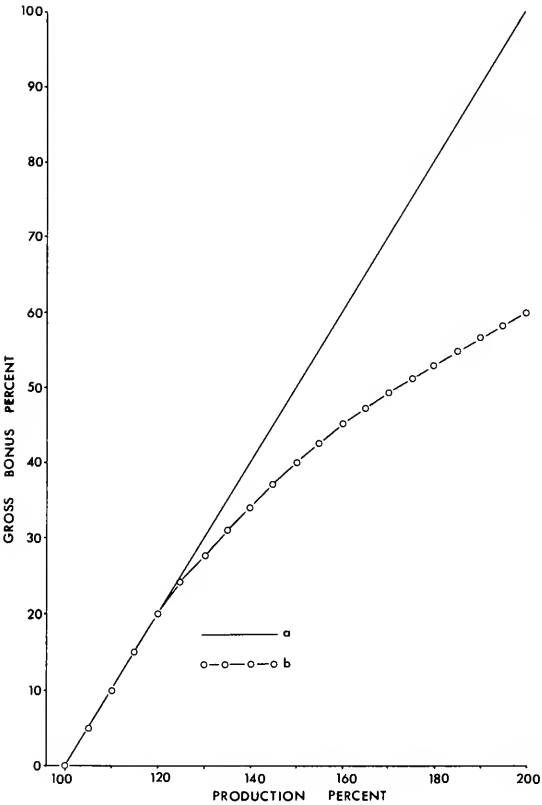


FIG. 3.—Degressive bonus graph for estimation of gross bonus per cent from production per cent: (a) Linear relationship, (b) degressive relationship used in this project.

for all members of a team. Thus a fast, accurate encoder raised the bonus per cent for the whole team while a slow, inaccurate encoder had the reverse effect. Individual statistics were calculated and tabulated (Fig. 2) so that the supervisor could investigate slow or inaccurate encoding at monthly intervals. The degressive bonus graph (Fig. 3) was proposed by the Workstudy Section as a necessary part of such a bonus incentive scheme (Pieters, 1974). Beyond a production of 120 per cent, the team benefits the employer to an ever increasing extent with this relationship. The area between lines a and b (Fig. 3)

TABLE 3.—Penalty corresponding to error per cent. See text for explanation

Error (%)	Penalty (%)
1	—
2	—
3	3
4	5
5	7
6	9
7	11
8	14
9	17
10	20
> 10	no bonus

represent the profit of the employer at the expense of the employee. Such a graph is used principally to protect the health of the encoders (Pieters, pers comm. 1978) and to maintain the gross bonus at 20–30 per cent. Bonus calculation per team and not individual is another prerequisite of such a scheme. The penalties corresponding to error per cent (Table 3) were devised so that a small error had at most a very limited effect on the net bonus while at higher error per cent levels the net bonus was drastically reduced and finally no bonus was paid for an error per cent greater than 10. The scale was intended to encourage accurate encoding above mere speed.

The number of hours worked by each encoder and each team checker was entered daily on an Attendance Register and Pay Sheet (Fig. 4). At the end of the encoding period the hours worked were totalled and payment calculated according to the formula given in Fig. 4. Net bonus per cent was obtained from calculations described above. Basic hourly rates of payment at the termination of encoding were: encoder: R2,50; team checker: R3,20; bonus controller and supervisor: R3,75. Only encoders and team checkers participated in the bonus incentive scheme.

DATA CODING FORM AND KEY-PUNCHING OF DATA

An example of a completed encoding form is given in Fig. 5. The form was specifically designed to expedite the encoding operation and be suitable for key-punching on 80-column cards. The first line of the form was completed for the first sheet in each species cover only and this information was duplicated to following forms by computer until replaced by the next occurrence of a first line. Information common to all the specimens in a species folder, including identi-

MONTHS	JANUARY - FEBRUARY 1976	TEAM	3	HOURLY RATE	\$2.50 A
	PERSONNEL NUMBER		5 100762431	NO. OF HOURS	48 B
SURNAME AND INITIALS		E. KING		NET BONUS	\$4.16 C
				TOTAL PAY	\$1669.92 D

$$O = A \times H + (A \times B \times \frac{C}{100})$$

WEEK	1	a	b	2	a	b	3	a	b	4	a	b	5	a	b	SUB-TOTALS	
MONDAY	INITIALS	E	K	E	K	E	INITIALS	E	K	E	INITIALS	E	K	E	INITIALS	E	8
	FROM/TO	7:00-21:00		FROM/TO	7:00-21:00		FROM/TO	7:00-21:00		FROM/TO	7:00-21:00		FROM/TO	7:00-21:00			
	HOURS	4		HOURS	4		HOURS	0		HOURS	0		HOURS	0			
TUESDAY	INITIALS	E	K	E	K	E	INITIALS	E	K	E	INITIALS	E	K	E	INITIALS	E	12
	FROM/TO	7:00-21:00		FROM/TO	7:00-21:00		FROM/TO	7:00-21:00		FROM/TO	7:00-21:00		FROM/TO	7:00-21:00			
	HOURS	4		HOURS	4		HOURS	4		HOURS	0		HOURS	0			
WEDNESDAY	INITIALS	E	K	E	K	E	INITIALS	E	K	E	INITIALS	E	K	E	INITIALS	E	15
	FROM/TO	7:00-21:00		FROM/TO	7:00-21:00		FROM/TO	7:00-21:00		FROM/TO	7:00-21:00		FROM/TO	7:00-21:00			
	HOURS	4		HOURS	4		HOURS	4		HOURS	3		HOURS	0			
THURSDAY	INITIALS	E	K	E	K	E	INITIALS	E	K	E	INITIALS	E	K	E	INITIALS	E	13
	FROM/TO	7:00-21:00		FROM/TO	7:00-21:00		FROM/TO	7:00-21:00		FROM/TO	7:00-21:00		FROM/TO	7:00-21:00			
	HOURS	4		HOURS	4		HOURS	2		HOURS	3		HOURS	0			
FRIDAY	INITIALS			INITIALS			INITIALS			INITIALS			INITIALS			0	0
	FROM/TO			FROM/TO			FROM/TO			FROM/TO			FROM/TO				
	HOURS	0		HOURS	0		HOURS	0		HOURS	0		HOURS	0			
TOTALS		16		16			10			6			0			48	

CERTIFIED CORRECT : BONUS CONTROLLER

FIG. 4.—Example (slightly reduced) of completed Attendance Register and Pay Sheet.

[illegible]

FIG. 5.—Example (reduced from A4 size) of completed Backlog Coding Form.

Shortly after encoding commenced, a 240-character per record key-to-tape data entry system replaced the IBM 029 card punches. If it had been known that such a system was due, a form with longer records and no 'auto dup' fields would have been designed. It is fortunate that it was not necessary to punch computer cards throughout the project as more than 2 300 boxes of cards would have been required and the task of processing and storing them would have been much more difficult than that of a few hundred magnetic tapes.

Encoding forms were numbered consecutively by the encoding supervisor by means of a numbering machine (Fig. 5) and then stapled into bundles of about 50. Each bundle was given a header form and consecutive bundle number. Batches of 20 bundles were submitted for key-punching and computer processing.

Specimens were accessioned piecemeal to computer disk packs in three groups of 150 000 and the remainder (about 60 000). The accessioning programme edited each specimen and listed errors. Errors were corrected by means of the same encoding form preceded by a different header form. Another programme finally converted correct and corrected specimens to the PRÉCIS data base.

ITEMS AND THEIR CODE EQUIVALENTS

It was decided that as far as possible, items would be given a numeric code (see Morris, 1974 for discussion). Exceptions were collectors' names, common names and locality names. Some descriptive text would be entered in full but would not be searchable. A list of items captured during the backlog encoding is given in Table 4 and an example of a complete

TABLE 4.—Items encoded during backlog encoding (U=uncoded, C=coded, T=text)

1 Encoding date	26 Main fruit colour (C)
2 Encoder	27 Life form (C)
3 Taxon number	28 Annual/perennial (C)
4 Cabinet and shelf number	29 Woody/herbaceous (C)
5 Quarter-degree grid (C)	30 Evergreen/deciduous (C)
6 Latitude and longitude (U)	31 Weed/encroacher (C)
7 Region (C)	32 Actually or potentially used (C)
8 Date collected	33 Collector's number (U)
9 Altitude and units (C)	34 Height and units (C)
10 Abundance (C)	35 Diameter at breast height and units (C)
11 State of the specimen (C)	36 Utilized by (C)
12 Special record (C)	37 Economic property (C)
13 Type status (C)	38 Collector's name (U)
14 Label language (C)	39 Major locality name (U)
15 Substrate (C)	40 Minor locality name (U)
16 Moisture regime (C)	41 Precise location (T)
17 Slope (C)	42 Miscellaneous notes (T)
18 Aspect (C)	43 Economic narrative (T)
19 Soil colour (A and B horizons) (C)	44 Common name (U) and language (C)
20 Presence of grey mottles (C)	45 Number of duplicate sheets
21 Soil type (C)	46 Specimen or photograph of specimen (C)
22 Biotic effects (C)	
23 Vegetation type (C)	
24 Veld type (Acocks, 1953)	
25 Main flower colour (C)	

backlog coding form is given in Fig. 5. Codes used under each item are listed below, together with notes on their use and conventions used by the encoders, where appropriate. The sequence is that of the encoding form.

1. Encoding date

Two-digit codes for the month and day of encoding were recorded. The year of encoding was obtained from the batch header form.

2. Encoder code

Each encoder was assigned a unique, consecutive, three-digit code and each of the five encoding teams had a one-digit code. Thus 0394 represents encoder 39 from team four.

3. Taxon number

The seven-digit genus code and four-digit species code (see Morris & Glen, 1978) were taken from the outside of the folders containing the specimens. An extra trailing zero was added to the species number by computer on conversion to allow for the future subdivision of an extant species into 100 new specific and sub-specific categories instead of only 10. The following special species codes were used:

- 9999 Tropical African type specimens and southern African material identified to genus only
- 9998 Hybrids (some hybrids also coded '9999')
- 9997 Cultivated, exotic species

Although a few were encoded, it was decided that in general exotic species would be omitted.

4. Cabinet number

Cabinets in each of the wings were given consecutive three-digit numbers, starting with '001' in each wing. Within each cabinet, shelves were numbered from top to bottom and left to right with two-digit numbers.

5. Quarter-degree grid

The latitude and longitude part of the code was entered as it appeared on the specimen. The letters, A, B, C and D, were converted to 1, 2, 3 and 4, respectively, before encoding. Where half- and quarter-degree codes were missing, a code of '0' was used.

6. Latitude and Longitude

Seconds, if given, were rounded to minutes before encoding. Where a range was given, the midpoint was coded.

7. Region

Black States within South Africa were coded as major or minor locations and for pragmatic reasons were given the region code of the province of which they were previously part. The codes used were:

01 Angola	07 Orange Free State / <i>Oranje-Vrystaat</i>
02 Botswana / Bechuana-land/Ngamiland	08 Rhodesia/Rhodesië
03 Cape Province / <i>Kaap-provinsie</i>	09 South West Africa/Capri/Namibia
04 Lesotho/Basutoland/ <i>Basoetoeland</i>	10 Swaziland
05 Mozambique / <i>Mosambiek</i>	11 Transvaal
06 Natal	12 Not these
	00 Unknown

Code 12 was used for other countries, in which case the name of the country was given as a major or minor location. The following region code conventions were adopted:

British Bechuanaland (usually Mafeking and surroundings)=03	Namaland=09
Boesmanland (without mention of Province or country)=03	Namaqualand=03
Great Namaqualand=09	n'Gamiland=02
Klein Namaqualand=03	Northern Ngamiland=09
Maputoland=06	Sekukuniland=11
	Tembuland=03
	Tongaland=06
	Zululand=06

8. Date collected

The date on which the plant was collected was encoded in full. Missing dates, or parts of dates, were coded as '00'. In the case of a range being given, the earlier date was coded. The date on which the plant had flowered, according to the label, was used if the specimen had flowers and no other date was given. If the specimen was not flowering and only flowering date was given, date collected was entered as '00000000' (i.e. unknown) and flowering date was given as a miscellaneous note.

9. Altitude and units

Altitude was entered, right-justified. The midpoint of an altitude range was coded. The codes '1'=feet and '3'=metres were used for the units code.

10. Abundance

Four basic codes were used, each of which could be prepositioned by 'locally'. 'Locally', 'scattered' and 'local' without accompanying indication of abundance were, however, not coded. The codes were:

- 1 rare/very occasional/sparse/uncommon/*seldsaam/skaars*
- 2 locally rare/*plaaslik seldsaam*
- 3 occasional/infrequent/*toevallig/matig/nie volop nie*
- 4 locally occasional/very localized/*plaaslik toevallig*
- 5 common/fairly common/co-dominant/frequent/*algemeen/wydersprei/volop*
- 6 locally common/localized/*plaaslik algemeen*
- 7 abundant/frequently abundant/very frequent/*baie volop*
- 8 locally abundant/*plaaslik baie volop*

Additional codes for very rare and locally very rare have been added subsequently and distribution (i.e. local or widespread) has been separated from abundance. (In all cases where alterations have been made

to code lists the necessary alterations have been made to the data bank and the 'new' codes will be used exclusively in future.)

11. State of specimen

The presence and maturity of flowers, fruits, roots and leaves were coded after inspection of the specimen. The code for 'present' was not used if the encoder could determine whether the organ was mature or immature. For specimens of grasses and other families with reduced or small flowers, flowers and fruits were coded 'present' if either was visible. State of specimen of bryophytes was always coded '0000'. Side roots and root hairs had to be present before roots were coded 'present', 'mature' or 'immature'. Photographs of types were always coded '0000'. The following codes were used for the state of flowers, fruits, roots and leaves:

- 1 absent/*afwesig*
- 2 immature/*jonk/onvolwasse*
- 3 mature/*volledig ontwikkel/volgroei*
- 4 present/*teenwoordig*

12. Special record

A code was allocated for specimens collected for a special purpose. A rubber stamp or special label on the herbarium sheet usually indicated a special record. Codes allocated were:

- 000 not special record/*nie spesiale versameling nie*
- 001 Eland food study/*Elandkosstudie*
- 002 SKF alkaloid study/*SKF alkaloïdestudie*
- 003 Lamziekte survey/*Lamziekte opname*
- 004 Stijfsiekte survey/*Stijfsiekte opname*
- 005 Dunsiekte survey/*Dunsiekte opname*
- 006 Bovine staggers survey/*Stootsiekte opname*
- 007 Pollen studies (UOFS)/*Stuifmeel studies (UOVS)*
- 008 Anatomy study/*Anatomiese studie*
- 009 CSIR alkaloid survey/*WNNR alkaloïd opname*
- 010 Bushmen food study/*Boesmanskosstudie*
- 011 Cancer research/*Kankernavorsing*
- 012 Economic plants of the Kung Bushman/*Ekonomiese plante van die Kung-Boesman*
- 013 Study of Tswana names and uses/*Studie van Tswana name en gebruikte*

13. Type status

All specimens found in type covers as well as specimens with a note of type status in ordinary folders were allocated a type status code. Where more than one type status was given for a specimen, the lowest code number was assigned, except for 'isotype' which was coded in preference to 'neotype', 'lectotype' and 'type'. The codes were:

- | | |
|---|--------------------------------|
| 0 no status/ <i>geen status nie</i> | 4 neotype/ <i>neo-tipe</i> |
| 1 holotype/ <i>holo-tipe</i> | 5 lectotype/ <i>lekto-tipe</i> |
| 2 syntype/ <i>cotype/syn-tipe/ko-tipe</i> | 6 type/ <i>tipe</i> |
| 3 paratype/ <i>para-tipe</i> | 7 isotype/ <i>iso-tipe</i> |

14. Label language

The language in which the majority of the original label was written was coded as follows:

- | | |
|----------------------------|--|
| 1 Afrikaans | 7 Italian/ <i>Italiaans</i> |
| 2 English/ <i>Engels</i> | 8 Portuguese/ <i>Portugees</i> |
| 3 Latin/ <i>Latyn</i> | 9 Spanish/ <i>Spaans</i> |
| 4 Dutch/ <i>Nederlands</i> | 0 other/unknown/ <i>ander/onbekend</i> |
| 5 French/ <i>Frans</i> | |
| 6 German/ <i>Duits</i> | |

15. Substrate

This item was coded as follows (present code numbers in parenthesis):

- 1 soil/mud/sandy flats/*grond/modder/sandvlaktes* (01)
- 2 stony soil/between rocks/*klipperige grond* (02)
- 3 bare rock/*blootgestelde rots* (03)
- 4 talus/scree (04)
- 5 cliff face/rock crevices/*kranswand* (05)

- 6 termite mound/termitaria/*termiethoop* (06)
- 7 beach dunes/dune forest/*kusduine/duinwoud* (07)
- 8 desert dunes/*woestynduine* (08)
- 9 other/plant growing on another plant/*ander/plant groei op ander plant* (10)

An additional code, 'in water' (09) has been added subsequently. In the case of coding 'other', details were entered under miscellaneous notes. Plants noted to be growing in or on granite, dolomite, sandstone or another rock type were coded '2' and if the colour of the rock was given, it was coded as the colour of the B-horizon soil (see below). Sandy flats were coded '1' for substrate, '02' for soil type and '1' for slope. Dune forest was also coded as vegetation '7'. Code '1' (soil) was only used if one of the following words, or their Afrikaans equivalents, occurred on the label: clay, gravel, sand, sandy, soil, turf.

16. Moisture regime

This item was coded in conjunction with substrate, using the following codes:

- 01 poorly drained soil/*swak gedreineerde grond*
- 02 well-drained soil/*goed gedreineerde grond*
- 03 pan/depression/edge of pan/*holte*
- 04 seepage area/*syfergebied*
- 05 marsh/swamp/bog/*vlei/moeras*
- 06 floodplain/*vloedvlakte*
- 07 river/streambank/near river/*rivier/spruitoewer*
- 08 river/stream/burn/*rivier/stroom*
- 09 river or stream bed/*rivier- of spruitbedding/omurumba/oshona*
- 10 ditch/donga/furrow/water course/*sloot/spoelsloot*
- 11 lake/dam/weir/*meer/dam/stuwal*
- 12 estuary/sea/lagoon/river mouth/littoral/*mangroves/strand-meer/riviermond/see*
- 13 in water
- 14 other/*ander*

Code '07' was also used for 'next to river', 'near creek', 'riverine' (except 'riverine forest' and 'riverine bush', which were coded '7' under vegetation only, 'waterfall' and 'stream bank'. 'Above river' and place names (e.g. Tugela Mouth) were not coded here. All specimens coded '13' have been given substrate code '09' and code '13' has been removed from moisture regime.

17. Slope

The codes for slope were:

- 1 plain/flat/sandy flats/*vlakte/gelykte*
- 2 gentle/*effens*
- 3 moderate/*matige*
- 4 steep/*steil*

'Plateau' and 'slope' without qualifiers were not coded.

18. Aspect

Aspect was coded on the following eight-point scale, provided it was clear that the collector was referring to aspect and not location (i.e. south of . . .):

- | | |
|-------------------------------|-------------------------------|
| 1 north/ <i>noord</i> | 5 south/ <i>suid</i> |
| 2 north east/ <i>noordoos</i> | 6 south west/ <i>suidwes</i> |
| 3 east/ <i>oos</i> | 7 west/ <i>wes</i> |
| 4 south east/ <i>suidoos</i> | 8 north west/ <i>noordwes</i> |

19. Soil colour

On very few occasions, soil colour was mentioned on labels. Where the soil horizon was not named, the colour was coded as that of the A-horizon. Rock colour was coded as that of the B-horizon. The codes used were:

- 1 white/*wit*
- 2 light grey/*lig grysvaai*
- 3 grey/grey-brown/beige/fawn/*grysvaai*
- 4 yellow-brown/*geelbruin*
- 5 red/*rooi*
- 6 black/*swart*

20. Grey mottles

A code for the presence of grey mottles within the soil profile was included on the advice of soil scientists but as this information was virtually never given by collectors, the item was not recorded after about 50 000 specimens had been encoded. It is now included in the data bank as code '11' of soil type.

21. Soil type

The soil type was described by up to four of the following codes:

- 01 gravel/shale/gritty/growwe sand/gruisgrond
- 02 sand/sandy/sand
- 03 loam/leem
- 04 clay/turf/klei/turf
- 05 humus-rich/peaty/humus-vrugbaar
- 06 salty/brak
- 07 on calcrete/limestone/calcareous soil/kalkklip
- 08 on laterite/ferricrete/ouklip
- 09 disturbed soil/versteurde grond
- 10 eroded/geërodeer
- 11 other/ander (12)

'Grey mottles' (11) were subsequently added and code '11' was changed to '12'. 'Sandveld', 'sand flats' and 'sand forest' were coded '02'; 'kalkveld' was coded '07' under this item and vegetation type was coded '4'. 'Sand on calcrete' was coded '02' and '07'. 'Dolerite soil' and 'alluvial soil' were coded as sub-strate '1' only. 'Disturbed soil', included as code '09' of soil type was not coded again under biotic effects.

22. Biotic effects

Biotic effects noted on labels were coded by means of up to three of the following codes:

- 01 cultivated land/ploughed/landerye
- 02 abandoned land/fallow/ouland
- 03 planted pasture/aangeplante weiding
- 04 plantation/plantation margin/plantasie
- 05 garden/lawn/tuin
- 06 roadside/railwayside/langs pad/langs treinspoor
- 07 heavily grazed/trampled/swaar beweij/oorbeweij/uitgetrap
- 08 recently burnt/onlangs gebrand
- 09 disturbed-other/versteurde-ander
- 10 no effect seen/undisturbed/rested/geen invloed waargeneem nie

The following conventions were adopted in the coding of biotic effects. A firebreak was not considered as '08' and disturbed soil was not '09'. In a National Botanic Garden, or similar institution, code '05' was only used if it was stated that the specimen was cultivated. If the locality was a domestic garden, or the locality could be assumed to be other than a National Botanic Garden or similar institution then code '05' was assigned even though the specimen was not specifically said to be cultivated. Code '08' was used for burns of up to one year old, if the age of the burn was given.

23. Vegetation

The following codes were used for describing the vegetation in which the plant was collected:

- 1 desert/semi-desert/woestyn
- 2 karoo/karooveld
- 3 grassland/sandveld/grasveld/veld
- 4 savanna/bushveld/thornveld/tree veld/open veld/parkland/grasveld met bome/kalkveld
- 5 woodland/bush/boomveld/bos
- 6 scrub/thicket/among shrubs/digte bos/kreupelhout/ruigte
- 7 forest/sand forest/dune forest/riverine forest/forest margin/wood
- 8 fynbos/heath/macchia/sclerophyll scrub/fynbos
- 9 other/ander

The term 'bush' was coded '5' unless associated with a measurement of height, in which case the term was

taken as a life form. If vegetation had been recently burnt, the vegetation type was assumed to be grassland unless another vegetation type was given.

24. Veld type

The two-digit veld type number assigned by Acocks (1953) was coded when given on the label.

25. Flower colour

The dominant flower colour, as noted on the label, and not as observed on the dried specimen, was coded as follows:

- 01 white/cream/wit/room
- 02 grey/silver/grys
- 03 yellow/saffron/geel
- 04 pink/rose/cerise/pienk
- 05 orange/amber/oranje
- 06 red/magenta/scarlet/maroon/rooi/persrooi/skarlaken/wynkleur/karmosyn
- 07 mauve/purple/violet/heliotrope/lilac/vermilion/pers
- 08 blue/blou
- 09 green/groen
- 10 brown/buff/bruin
- 11 black/swart

26. Fruit colour

The flower colours given above were also used for fruit colour. The codes were in each case greater by 20. Thus, white fruit was '21' and black '31'.

27. Life form

The following codes were used:

- 01 tree/boom
- 02 shrub/undershrub/suffrutex/struik
- 03 dwarf shrub/semi-shrub/half shrub/dwergstruik/halfstruik
- 04 herb/forb/hemicryptophyte/kruid
- 05 geophyte/bulb/bulbous plant/geofiet/bolplant
- 06 epiphyte/epifiet
- 07 climber / creeper / scandent / vine / twiner / liane / klimplant / ranker
- 08 parasite/parasiet
- 09 succulent/semi-succulent/vetplant
- 10 aquatic/hydrophyte/waterplant

Plants with succulent or fleshy leaves were not coded '09' unless life form was also specified.

28. Annual etc.

The life cycle of the specimen was coded as follows:

- 1 annual/eenjarige
- 2 ephemeral/efemeer
- 3 biennial/tweejarige
- 4 perennial/perennial rootstock/meerjarige

When 'herbaceous' was coupled with 'woody rootstock' the specimen was not coded as '4'.

29. Woody etc.

This item was coded as follows:

- 1 woody/houtagtig
- 2 herbaceous/kruidagtig

'Woody rootstock' was not coded under this item. An additional code, half-woody, has been added subsequently.

30. Evergreen etc.

This item was coded as follows:

- 1 evergreen/immergroen
- 2 semi-deciduous/half bladwisselend
- 3 deciduous/bladwisselend

31. Weed etc.

This item was coded as follows:

- 1 weed/ruderal/onkruid/puinhoopplant
- 2 encroacher/indringer
- 3 weed & encroacher/onkruid en indringer

An additional code for exotic plants has been added subsequently.

32. Actual/potential use

Actual uses as noted on labels (e.g., used as a poison) were separated from potential uses (e.g., could be a food plant) by means of this code. Use of this item meant that utilized by and economic property had to be entered as well. 'Poison' without further elaboration was taken as an actual use. Codes were:

- 1 actually used/*werklik gebruik*
- 2 potential use/*potensieel bruikbaar*

33. Collector's number

The collector's number, exactly as given on the label, was entered, left-justified. If no collector's number was given on the label, a PRE accession number, prefixed by 'PRE' was used for this item. If the specimen had a printed label of the Transvaal Museum (TM), Herbarium of the University of the Witwatersrand (MOSS), South African Museum (SAM), National Botanic Gardens (NBG), Herbarium of the University of the Orange Free State (BLF), Stellenbosch Unit of the National Herbarium (STE), Durban Unit of the National Herbarium (NH), Herbarium of the Forestry Department (FD) or Bolus Herbarium (BOL) and the number was that of the herbarium and not the collector, the 'collector's number' was prefixed with the letters given above in parentheses. Where specimens had both a personal collector's number as well as a herbarium accession number, the former was always used. If the initials of the collector were given as part of the number, they were omitted.

34. Height and units

The height of the plant, rounded to three digits if necessary was coded. The mid-point of a range was entered. When two or more distinct heights were given, the greater height was used. Units, for both height and diameter at breast height, were coded as follows:

- | | |
|-----------------------|----------------------------------|
| 1 feet/ <i>voet</i> | 3 metres/ <i>meter</i> |
| 2 inches/ <i>duim</i> | 4 centimetres/ <i>sentimeter</i> |

35. Diameter at breast height and units

The conventions noted under height also applied to the coding of this item.

36. Utilized by

Up to five codes were used to describe the uses of the plant. If more from one code was used then only one economic property was allowed, and *vice versa*. The following codes were applicable:

- 81 man/*mens*
- 82 stock/*vee*
- 83 cattle/*beeste*
- 84 sheep/*skape*
- 85 goats/*bokke*
- 86 horses/donkeys/*perde/donkies*
- 87 other mammals/*game/ander soogdiere*
- 88 birds/*voëls*
- 89 fishes/reptiles/amphibians/*visse/reptiele/paddas*
- 89 fishes/reptiles/amphibians/*visse/reptiele/amfibieë*
- 90 invertebrates (excluding bees)/*ongewerweldes (uitsluitende bye)*
- 91 honey bees/*heuningbye*

Codes '90' and '91' were subsequently reversed so that 'bees' became '90' and 'other invertebrates' '91'. Unless otherwise specified, 'eaten' and 'not eaten' on labels were assumed to apply to stock (code '82') and 'poison' was not coded under the utilized by item unless qualified.

37. Economic property

Up to five of the following codes were used to describe economic properties of specimens (present code numbers in parentheses):

- 01 poison/*gif* (01)
- 02 poison: arrow/*pylgif* (02)
- 03 poison: criminal/*gif: kriminele doeleindes* (03)
- 04 medicinal/*medisyne* (06)
- 05 drug/*verdoewingsmiddel* (07)
- 06 irritant/allergy/*prikkelmiddel/allergie* (08)
- 07 tainting e.g. milk/*bysmake aan melk ens.* (09)
- 08 magic/ritual/*toor kuns/ritueel gebruik* (10)
- 09 eaten/palatable/*geëet* (11)
- 10 not eaten/*nie geëet nie* (12)
- 11 beverage/*drank* (13)
- 12 cordage/*toue/vlegwerk* (14)
- 13 paper/*papier* (15)
- 14 clothing/*klere* (19)
- 15 structural/baskets/mats/brooms/*gebruik vir konstruksie/mandjies/matjies/besems* (20 and 21)
- 16 aromatic/snuff/*aromaties/snuif* (22)
- 17 cosmetic/*grimering* (23)
- 18 beads/*krale* (24)
- 19 soap/*seep* (26)
- 20 oil/*olie* (27)
- 21 gum/resin/*gom/harpuis* (28)
- 22 dye/*kleurstof* (29)
- 23 fuel/*brandstof* (30)
- 24 sand binder/*sandbinder* (31)
- 25 ground cover/lawn grass/*grondbedekking* (32)
- 26 hedge/windbreak/*heining/windskerm* (33)
- 27 shade/*skaduwee* (34)
- 28 garden ornamental/*sierplant* (35)
- 30 other—see miscellaneous notes/*ander—sien algemene notas*
- 30 other—see miscellaneous notes/*ander—raadpleeg algemene notas*

Where more than one distinct economic note was given for a specimen, the first was coded and the subsequent notes entered in the economic property narrative field only. The following codes have been added subsequently:

- | | |
|-----------------------|--------------------------|
| medicine—internal (4) | other building (18) |
| medicine—external (5) | other decorative (25) |
| thatching (16) | other horticultural (36) |
| timber (17) | crop (37) |

38. Collector(s)

In the case of one-person collectors, the surname, followed by initials without full-stops were entered. Where more than one collector's name was given on the label, surnames only were coded, each separated by two blank spaces. Where no collector's name was given, the collector was coded as 'PRE'. When a specimen was collected by one person (usually a layman) for another (usually a well-known botanist) and both names appeared on the label, the name and number of the botanist were encoded and the name of the actual collector was given in a miscellaneous note.

39. Major location name

Difficulty was experienced by encoders with the choice of major and minor location names. Pages of examples were drawn up to illustrate some of the many possibilities.

A major location name was only given if a minor location name was also coded; otherwise the major location name was entered in the minor location name field. It was intended that a large geographical unit, but not a region (see above) be entered. Examples are mountain ranges and magisterial districts.

40. Minor location name

It was intended that a small geographical unit be coded as the minor location name. Examples would be towns and cities. In general, a minor location is

TABLE 5.—Alphabetical list of abbreviations used in major, minor and precise locality fields

<i>Afdeling</i>	=AFD.	<i>Landbou</i>	=LANDB.
<i>Afdelingsraad</i>	=AFD. RAAD	<i>Metres/Meters</i>	=M.
<i>Agriculture/Agricultural</i>	=AGR.	<i>Miles/Myl</i>	=MI.
<i>Between</i>	=BETW.	<i>Mount/Mountain</i>	=MT.
<i>Bosbou</i>	=BOSB.	<i>Navorsingstasie</i>	=NAV. STA.
<i>Cultivated</i>	=CULT.	<i>Nasionale/National Park</i>	=NAT. PARK
<i>Centimetres</i>	=CM.	<i>Nature Reserve/Natuurreserveaat</i>	=NAT. RES.
<i>District</i>	=DIST.	<i>Near</i>	=NR.
<i>Distrik</i>	=DIST.	<i>North/Noord</i>	=N
<i>Division</i>	=DIV.	<i>Northwest/Noordwes</i>	=NW.
<i>Duiem</i>	=DM.	<i>Pasture</i>	=PAST.
<i>East/Oos</i>	=E.	<i>Research</i>	=RES.
<i>Experimental</i>	=EXP.	<i>South/Suid</i>	=S.
<i>Feet</i>	=FT.	<i>Station/Stasie</i>	=STA.
<i>Flowers</i>	=FLS.	<i>University</i>	=UNIV.
<i>Forestry/Forest</i>	=FOR.	<i>Voet</i>	=VT.
<i>Inches</i>	=IN.	<i>West/Wes</i>	=W.
<i>Kilometres</i>	=KM.		

situated within a major location. The collecting site had to be within the arbitrary limit of 16 km (10 miles) from the minor location or 'near' the minor location, if an exact distance was not given. Farm names were not used for major and minor locations except in South West Africa and Botswana, or where no other locality name was given. A list of abbreviations was prepared (Table 5) and these were used throughout for the spelling of location names. Points of the compass in names (e.g. Pretoria North) were not abbreviated. Specimens collected between two towns or on the boundary of two magisterial districts were not given major or minor location names through the use of these town or district names.

41. *Precise location*

The precise location, as given on the label, was recorded on two lines of the coding form. This entry was made as complete as possible without unnecessarily repeating the major and minor locations. The standard list of abbreviations was used in this field as well.

42. *Miscellaneous notes*

The most important information not coded anywhere on the data form was entered in this field.

43. *Economic narrative*

The utilized by and economic property items were elaborated upon in this field.

44. *Common name and language*

The common name was entered in this field as it appeared on the label. The language of the entered common name was coded from the following list (present code numbers in parentheses):

01 Afrikaans (01)	18 Shangaan (19)
02 English/ <i>Engels</i> (02)	13 South Ndebele/ <i>Suid-Ndebele</i> (14)
03 German/ <i>Duits</i> (03)	14 South Sotho/ <i>Suid-Sotho</i> (15)
04 Dutch/ <i>Nederlands</i> (04)	15 Subia (16)
14 Basotho/ <i>Basoetoe</i> (05)	16 Swazi (17)
05 Bushman/ <i>Boesman</i> (06)	17 Tjimba (18)
06 Damara (07)	18 Tsonga (19)
07 Herero (08)	19 Tswana (20)
08 Himba (09)	20 Venda (21)
09 Kavango (10)	21 Xhosa (22)
10 Mafwe (11)	22 Zulu/ <i>Zoeloe</i> (23)
11 North Sotho/ <i>Sipedi/Noord-Sotho</i> (12)	00 other/unknown/ <i>ander/onbekend</i>
12 Ovambo (13)	

The label language codes were kept separate from the common name language codes.

45. *Number of duplicate sheets*

If there was more than one complete specimen of a collector's number within a species folder, the number of duplicates was entered in column 43-44 of the last line of the form. Where parts of a specimen were mounted on more than one sheet, these were not considered as duplicates and all such sheets were taken into account in the determination of the state of the specimen (see above).

46. *Photograph code*

Specimens encoded from photographs mounted on herbarium sheets and filed in species covers were identified by means of a code 'PH' on the data form in columns 45-46 of the last line of the form.

COSTS AND DURATION OF OPERATION

It was anticipated that encoding of all the estimated 500 030 specimens housed in the National Herbarium would take the encoding team two to three years. Coding was begun during June 1974 and was effectively completed by December 1976. As a result of continuing specimen collection (some 20 000 new accessions per annum) encoding will continue until all collectors are using the new collector's form (see Morris & Glen, 1978: Fig. 3). A total of over 470 000 specimens were encoded (Table 6) and 38 500 man-hours were worked. The average cost per specimen was R0,258 and the average cost per man-hour was R3,14.

TABLE 6.—Statistics of the backlog encoding project

Encoding initiated.....	1974/06/03
Encoding terminated.....	1976/12/06
Number of specimens coded.....	470 243
Total man-hours worked.....	38 557
Total labour cost.....	R121 215
Average cost per specimen.....	R0,2578
Average cost per man-hour.....	R3,1438

Costs and statistics for each of the encoding periods for which Monthly Team Summaries were calculated are summarised in Table 7. Initially, costs per specimen were high as a result of intensive training of encoders without botanical background and the use of inefficient procedures. Costs dropped rapidly and stabilised at R0,23 to R0,26 per specimen while the norm was gradually increased. Towards the end of the period, costs rose slightly as a result of basic pay rate increases being awarded to encoders.

TABLE 7.—Herbarium backlog encoding monthly statistics

Report number	Month and year	Norm	Number of specimens coded	Man-hours worked	Amount paid	Cost per specimen
					R	R
1.....	6/74	9	3701	1347,5	2926,50	0,79
2.....	6/74	9	14554	1804,0	5604,05	0,39
3.....	7/74	11	25957	2106,0	6919,96	0,27
4.....	8/74	12	17073	1486,0	4811,30	0,28
5.....	9/74	14	19854	1605,0	4836,50	0,24
6.....	10/74	14	28400	2070,0	6379,30	0,22
7.....	1/75	14	22152	2064,0	6503,06	0,29
8.....	2/75	14	18832	1560,0	4914,75	0,26
9.....	3/75	14	25509	1995,0	6560,96	0,26
10.....	5/75	14	14053	1013,0	3557,06	0,25
11.....	5/75	14	23471	1669,0	5136,24	0,22
12.....	6/75	16	20566	1613,0	5119,18	0,25
13.....	7/75	16	14479	1144,5	3584,12	0,25
14.....	8/75	16	20649	1520,5	4763,84	0,23
15.....	9/75	16	20191	1580,0	5137,60	0,25
16.....	10/75	16	25615	1800,5	6198,43	0,24
17.....	1/76	16	13234	1219,0	3591,89	0,27
18.....	1/76	16	20858	1609,0	4699,44	0,23
19.....	2/76	16	21296	1643,0	4913,60	0,23
20.....	3/76	16	14837	1132,0*	3453,48	0,23
21.....	4/76	16	13560	1062,5*	3346,38	0,25
22.....	5/76	16	10192	767,0*	2507,17	0,25
23.....	6/76	16	13672	1165,5*	3633,97	0,27
24.....	7/76	16	12655	956,0*	3024,77	0,24
25.....	8/76	16	8594	625,0*	2163,98	0,25
26.....	9/76	16	9934	715,5*	2635,29	0,27
27.....	10/76	16	10638	864,0*	2776,53	0,26
28.....	11/76	16	5717	420,5*	1515,77	0,27

* Encoding for 3 hours per evening instead of 4 as previously.

DISCUSSION

The success of the project is attributed primarily to the bonus incentive scheme and the availability of a comprehensive encoder instruction manual. The bonus scheme and the part-time staff of 28 ensured that the task was completed within a relatively short period. For about the same cost, the operation could have been carried out in about 10 years by a smaller, full-time staff. Under those circumstances, it is likely that interest in the project would have waned and also that encoding standards and conventions would have altered more than under the circumstances actually imposed. Availability of an instruction manual facilitated the training of staff, enabled encoding standards to be maintained and allowed the use of an enforceable penalty scheme.

The codes, including synonyms and Afrikaans equivalents are given in full in this paper together with the coding instructions given to encoders. In this way, users of the data bank are informed about the conventions adopted and generalisations made. Any future operation of this kind should find this a useful foundation on which to build. The tables of Latin and German equivalents are included for the same reasons. It is not intended that where more than one word is given for a code they should be considered as synonyms in the strict sense but they indicate the range of variation within the concept included in the code. Translation lists from foreign languages should be used to obtain an understanding of the philosophy behind the use of its codes; my lists are not dictionaries. Use was made of inferences and assumptions in order to define codes clearly and to spell out encoder instructions. In a few cases, the codes indicated will be incorrect or misleading to a trained botanist in the context of all the information contained on a label. It was, however, impossible to define all possible

situations and a few such errors will obviously have escaped detection.

Most problems were experienced with the computer processing of the data and the physical handling of large volumes of data sheets, printouts and punch cards. Although computer processing falls outside the scope of this contribution, these problems are mentioned here. At initiation, this was the largest system on the Burroughs B6700 computer and although the computer was large enough, the operations room was not capable of handling the volume efficiently and keeping concise records of processed data tapes and system backup tapes. Although the problems diminished as experience was gained, a great deal of time was lost as a result. The need for efficient computer room control procedures with a project such as this cannot be over-emphasized. The volume of paper output to be scanned for errors was also underestimated and as a result handling of large stacks of paper was difficult. The single printout of every specimen which was made for manual checking purposes used over 100 boxes of computer paper. Storage of paper and punched data sheets in an accessible manner was also difficult to plan. Solutions would have been the use of computer output microfilm and a re-designed output format requiring fewer lines per specimen so that more specimens could have been listed on each page. It is fortunate that after about 200 boxes of computer cards had been punched a switch was made to key-punching onto magnetic tape. As mentioned earlier, handling of magnetic tapes is far easier than boxes of cards. It was found that computer processing could not keep pace with encoding and, similarly, error correction could not keep pace with computer processing. Processing and data correction therefore lagged further and further behind as the project continued.

It was hoped that manual vetting and correction of computer printouts could be made part of the bonus incentive scheme so that it could be completed in a short period as a distinct operation but this was not possible and vetting was carried out by the small team of permanent encoders who have taken over from the backlog encoding team.

The data bank is open-ended in that new accessions (about 20 000 a year) are being added continually. A special field data sheet has been designed for use by collectors who regularly submit specimens to the National Herbarium to obviate the need for encoding. A small team of permanent encoders has been responsible for encoding donations and exchanges not accompanied by the new field data sheet since the conclusion of the project reported here. This team is also responsible for the continuing correction of errors in the PRÉCIS data bank.

The error detection systems included in the bonus incentive scheme were successful in reducing the errors to an acceptable level. With the large volume involved, however, a certain number of errors were bound to slip through. A continuing programme of error correction will be maintained for a few years while the data bank is used and errors are discovered. The global editing of localities and collectors' names was planned from the outset and is proceeding satisfactorily. From alphabetical lists of all collectors and localities, mis-spellings are being removed by a qualified botanist. The addition of quarter-degree grids by computer from the list produced by Leistner & Morris (1976) at a later stage is being considered.

The costs given in this paper do not include those of key-punching, computer program writing and computer processing time. Also excluded are the costs of the manual checking of computer printouts and completion of error correction data forms. The costs of the systems analysis and time spent by the writer on the planning of the project are also omitted. These costs are not available but it is estimated that, if included, they would double or treble the expenses of encoding reported here. The benefits which the botanical community will gain from the project are, however, such that the expense will be amply justified.

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UITTREKSEL

Die enkodeering van inligting vanaf 470 000 bestaande herbariumeksemplare vir gebruik in 'n rekenaar-databank word beskryf as hulpmiddel vir kuratore en stelselontleeders wat gelyksoortige prosedure in hul eie herbariums wil toepas. Die voorbereiding van die herbariums, die enkoderingsprosedure, die nagaan van geënkodeerde eksemplare, koste en vergoeding van enkodeerders word beskryf. 'n Volledige lys van geënkodeerde items en hul kodes word gegee. Van die probleme wat aangetref is, word bespreek en die sukses van die projek tot op datum word kortliks geëvalueer. Sukses word toegeskryf aan die bonus-aanspooringsstelsel en die beskikbaarheid van 'n volledige instruksieboek.

REFERENCES

- ACOCKS, J. P. H., 1953. Veld types of South Africa. *Mem. bot. Surv. S. Afr.* 28: 1-192.
- BRENAN, J. P. M., ROSS, R. & WILLIAMS, T., 1975. *Computers in botanical collections*. London: Plenum Press.
- DYER, R. A., 1975. *The genera of Southern African flowering plants. 1. Dicotyledons*. Pretoria: Botanical Research Institute.
- DYER, R. A., 1976. *The genera of Southern African flowering plants. 2. Gymnosperms and Monocotyledons*. Pretoria: Botanical Research Institute.
- LEISTNER, O. A. & MORRIS, J. W., 1976. Southern African place names. *Ann. Cape Prov. Mus.* 12: 1-565.
- MORRIS, J. W., 1974. Progress in the computerization of herbarium procedures. *Bothalia* 11: 349-353.
- MORRIS, J. W. & DU TOIT, P. C. V., 1976. *Handbook for the encoding of herbarium specimens*. Pretoria: Botanical Research Institute (unpublished report).
- MORRIS, J. W. & GLEN, H. F., 1978. PRÉCIS the National Herbarium of South Africa (PRE) computerized information system. *Taxon* 27: 449-462.
- MORRIS, J. W. & LEISTNER, O. A., 1975. Progress with computerization of the National Herbarium, Pretoria. *Boisiera* 24: 411-413.
- PIETERS, J. L., 1974. *Verslag oor die ondersoek na die kodering van plantmonsters in die Nasionale Herbarium van die Navorsingsinstituut vir Plantkunde met die oog op rekenariserings gekoppel aan 'n direkte finansiële aanspooringsstelsel*. Pretoria: Department of Agricultural Technical Services (unpublished report).
- ROSS, J. H., LEISTNER, O. A. & DE WINTER, B., 1977. *A guide to contributors to the Flora of Southern Africa (F.S.A.)*. Pretoria: Department of Agricultural Technical Services.

Translocation heterozygosity in southern African species of *Viscum*

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ABSTRACT

Sex-associated and floating translocation complexes are characteristic of dioecious species of *Viscum*, but are virtually absent in monoecious species. The majority of dioecious species has fixed sex-associated translocation complexes with the male being the heterozygous sex. The sex-associated multivalent is usually $\odot 4$ (ring-of-four) or $\odot 6$, rarely $\odot 8$. Dioecious species without sex-associated translocations are much less common. Most of the dioecious species are also polymorphic for floating translocations, producing one or more additional multivalents ranging from $\odot 4$ to $\odot 12$. Floating translocations may be more frequent in species that do not have sex-associated translocations. Supernumerary chromosomes are also present in several species. Sex ratios are at unity in most dioecious species, but female-biased ratios may occur in some species. The high correlation between dioecy and translocation heterozygosity suggests that translocations are primarily associated with the origin and establishment of dioecy. Any rôle in the maintenance of biased sex ratios through meiotic drive is probably secondary. Sex-associated translocations may serve to stabilize dioecy by bringing the sex factors into close linkage. Subsequent structural rearrangements within a sex-associated translocation complex may bring the sex factors together in one chromosome pair, releasing floating translocations. The high frequencies of floating translocation heterozygosity in some species indicate that such heterozygosity also has adaptive value.

RÉSUMÉ

TRANSLOCATION HÉTÉROZYGOTE CHEZ DES ESPÈCES SUD-AFRICAINES DE *VISCUM*

Des complexes de translocation liés au sexe et flottants sont caractéristiques des espèces dioïques chez *Viscum*, mais n'existent pratiquement pas dans les espèces monoïques. La plupart des espèces dioïques ont des complexes de translocation fixes et liés au sexe, avec l'hétérozygotie du côté mâle. Le multivalent associé au sexe est habituellement $\odot 4$ (anneau de quatre) ou $\odot 6$, rarement $\odot 8$. Les espèces dioïques sans translocations liées au sexe sont beaucoup moins répandues. La plupart des espèces dioïques sont également polymorphiques pour des translocations flottantes, produisant un ou plusieurs multivalents additionnels qui s'étendent de $\odot 4$ à $\odot 12$. Des translocations flottantes peuvent se rencontrer plus fréquemment chez des espèces qui n'ont pas de translocation liée au sexe. Des chromosomes surnuméraires se rencontrent également chez plusieurs espèces. Dans la plupart des espèces dioïques la sex-ratio est de 1, mais dans certaines on peut trouver une déviation du côté femelle. Le degré élevé de corrélation entre la dioécie et l'hétérozygotie de la translocation suggère que les translocations sont associées primordialement à l'origine et à l'établissement de la dioécie. Tout rôle que pourrait jouer la poussée méiotique dans le maintien de sex-ratios faussés est probablement secondaire. Des translocations liées au sexe peuvent servir à stabiliser la dioécie en aboutissant à une association étroite entre les facteurs sexuels. Des réarrangements structuraux ultérieurs dans l'encheintre d'un complexe de translocation lié au sexe peuvent rassembler les facteurs sexuels dans une seule paire chromosomique en relâchant des translocations flottantes. La fréquence élevée des translocations hétérozygotes flottantes chez certaines espèces indique que pareille hétérozygotie possède également une valeur adaptative.

Viscum is a genus of mistletoes comprising about 100 species with an extensive range in the Old World. Its species parasitize a wide range of dicotyledonous trees and shrubs in a variety of forest and woodland habitats. Major centres of species diversity are Africa and Madagascar, but there is also a significant development of the genus in tropical and subtropical Asia. The extremes of its geographical range are reached in Europe, southern Africa, temperate Asia, and Australia. In southern Africa the genus is represented by at least 17 species, of which 9 are dioecious, 7 monoecious and one (*V. capense*) that has both monoecious and dioecious subspecies.

The flowers in *Viscum* are small and consistently unisexual. The basic inflorescence unit is a cymule, usually consisting of three minute flowers (1-3 mm wide), but in some species the flowers are solitary or in larger clusters. The monoecious species typically have the central flower of the cymule of one sex and the two lateral flowers of the other.

Dioecious species are common in Africa and Madagascar, and a few others are widely distributed in Europe and temperate Asia, but monoecious species are the rule in tropical Asia. In the dioecious species the cymules are still typically three-flowered, so that dioecy presumably involves a possibly simple conversion of all flowers to the same sex for all

cymules of a plant. Dioecy appears to be highly stable in its expression in *Viscum*, and mixed cymules are unknown in any of the dioecious entities we have studied.

The most common chromosome number among the African species of *Viscum* is $x=14$, and this is apparently the basic number for the genus (Wiens, 1975). The Madagascan species so far examined mostly have $x=13$, but more extensive data are needed before firm conclusions can be drawn. Some of the Madagascan species are more closely related to the species of *Viscum* of the Asian region than to those of Africa. The southern African species are especially interesting because of the high incidence of derived aneuploid chromosome numbers of $x=15$, 12, 11 and 10 occurring in this region.

Translocation heterozygosity was first reported for *Viscum* in the dioecious species, *V. fischeri* Engl. from eastern Africa (Wiens & Barlow, 1973; 1975). This species has a unique system of translocation heterozygosity in which male plants have a chromosome number of $2n=23$, and consistently produce seven bivalents and an open multivalent chain of nine chromosomes at meiosis. Female plants have a chromosome number of $2n=22$, form 11 bivalents at meiosis, and are thus chromosomally homozygous for the 11-chromosome genome. Translocation heterozygosity is therefore presumed to be sex-associated, with the male being the heterozygous sex and the 11- and 12-chromosome genomes female-determining and male-determining, respectively (Barlow & Wiens, 1976). Additional studies

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also revealed the presence of a strongly female biased sex ratio of approximately 1:2.

Further studies have indicated that sex-associated translocations are widespread in dioecious species of *Viscum*, but typically absent in monoecious species. A more extensive cytogenetic survey of the southern African species of *Viscum* is presented in this paper. The occurrence and distribution of translocation heterozygosity and supernumerary chromosomes are described and considered in relation to the origin and establishment of dioecy and to variations in the sex ratio.

METHODS

Flower buds were fixed in ethyl alcohol/acetic acid (3:1) and stored in absolute alcohol at -15°C whenever possible. Chromosomal constitution was determined from aceto carmine squash preparations of pollen mother cell, or embryo sac mother cell meiosis in some female plants. The latter involved dissection of a block of tissue containing the sporogenous cells from the base of the flower bud (there are no discrete ovules in *Viscum*), maceration in a solution of 1% HCl in 45% acetic acid on a slide for 2 min at 60°C , and light squashing.

The sex ratio for most species was determined directly from established populations in the field. Plants were mostly removed from the host for counting so that difficulties caused by clumped distributions and autoparasitism could be minimized.

Voucher specimens for each chromosome determination are deposited at the State Herbarium of South Australia (AD), Botanical Research Institute, Pretoria (PRE), and the Garret Herbarium, University of Utah (UT).

RESULTS

The chromosomal constitutions of 359 individuals were determined for 16 of the 17 species of *Viscum* currently recognized for southern Africa (Wiens & Tölken, 1979). Details of these determinations are given in the Appendix and selected characteristic configurations are illustrated in Fig. 1.

Monoecious species

All of the monoecious species were studied karyologically with the exception of *V. schaeferi*. In all but one of these the floral distribution is essentially constant and generally typical of monoecious species, with each cymule bearing both male and female flowers, with a central flower of one sex and lateral flowers of the other. In *V. capense* subsp. *hoolei*, however, the expression of monoecy is altered. Some plants produce mostly female flowers which possess basically female morphology, while other plants produce mostly flowers of typical male morphology and mature few fruits. The vegetative characters of *V. capense* subsp. *hoolei* agree generally with the dioecious *V. capense* subsp. *capense*; thus in subsp. *hoolei* monoecy probably represents a derived state resulting from modification of sex determination in a dioecious species. In other monoecious species of *Viscum*, e.g. *V. obovatum*, male and female flowers are produced together only at certain times, while at other times only female flowers occur in the bracteal cups (Wiens & Tölken, 1979). This is apparently a relatively common occurrence in monoecious species in other parts of the world (Danser, 1941).

The chromosomal data for the monoecious entities are summarized in Table 1. There is a general absence

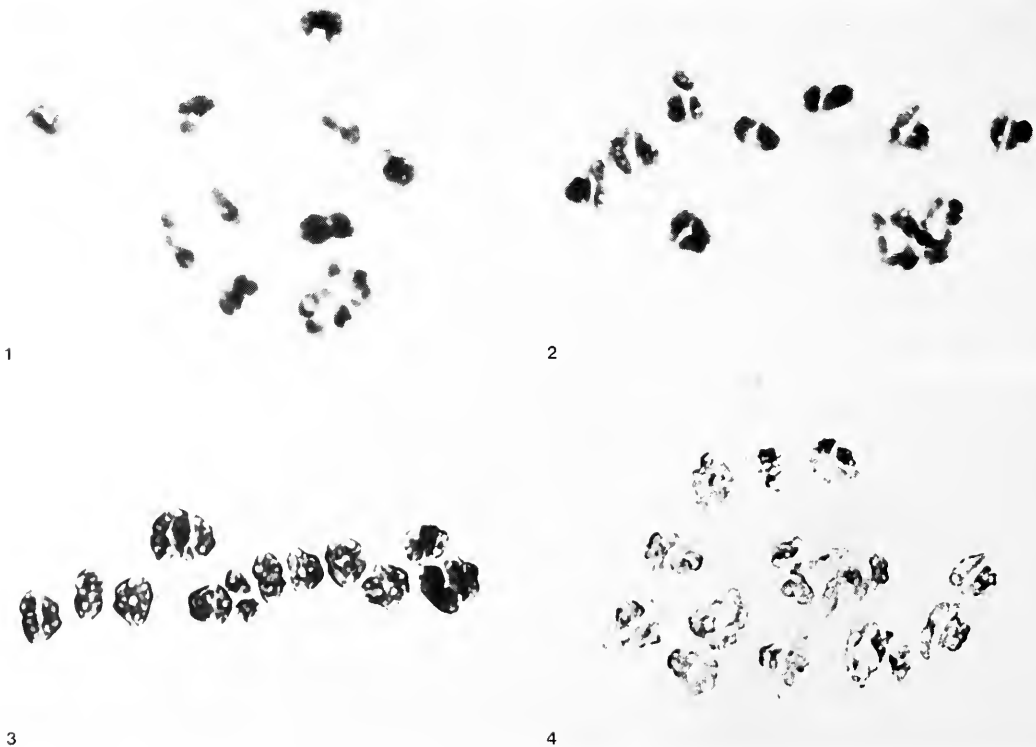


FIG. 1.—Pairing configurations of metaphase I chromosomes in African species of *Viscum*. 1, *V. subserratum* 9II O4 (W5305h). 2, *V. subserratum* 8II O6 (W5305f). 3, *V. continuum* 10II O4 (W5377b). 4, *V. obscurum* 10II O4 O6 (W5372b).

of translocation heterozygosity in these species, its only occurrence being recorded in a single individual of *V. capense* subsp. *hoolei* which has chromosome associations of eight bivalents and a ring of four chromosomes ($8\text{II}+\text{O}4$). This is in striking contrast to the situation in the dioecious species where translocation heterozygosity is probably universal, at least in some male plants (see below). As previously mentioned, in *V. capense* subsp. *hoolei* monoecy may be derived from dioecy, so that the translocation heterozygosity present may be the same as that found in the dioecious subspecies.

TABLE 1.—Summary of chromosome constitutions in southern African monoecious species of *Viscum*

	Chromosome no. (n)	No. of plants (Bivalents only)	No. of plants (Floating ○4)
<i>V. capense</i> subsp. <i>hoolei</i> *	10	10	1
<i>V. minimum</i>	14	1	
<i>V. nervosum</i>	14	6	
<i>V. obovatum</i>	12	5	
<i>V. rotundifolium</i>	14	20	
<i>V. spragueanum</i>	23	1	

* atypical monoecy: see text.

Chromosome numbers among the monoecious species are $n=10, 12, 14$ and 23 , but $n=28$ occurs in some monoecious species in eastern Africa (Wiens, 1975). *Viscum spragueanum* is probably consistently polyploid, but one tetraploid individual was discovered in *V. capense* subsp. *hoolei*, which is otherwise diploid. This situation contrasts sharply with that in the dioecious species, where only a single triploid plant was discovered in *V. verrucosum*. Although alternative explanations are possible, the rarity of polyploidy in the dioecious species could be related to a mechanism where sex is determined by a balance between strongly female- and male-determining X and Y factors, as originally proposed by Muller (1925).

Dioecious species

The chromosome constitutions of all of the dioecious southern African species of *Viscum* were analysed (Table 2). Translocation heterozygosity occurs in all 10 of the dioecious species, and these fall into two groups. The larger group (with 6 species) exhibits patterns in which the male plants are all heterozygous for at least one translocation complex. Only a few female plants were analysed for pairing relationships in the southern African species, but these were consistent with the assumption that *some* translocation rings are sex associated, occurring in male plants only, and that female plants are predominantly chromosomally homozygous and produce mostly bivalent associations. Thus where male plants occur with more than one translocation ring, the additional rings presumably also occur in female plants. The sample sizes in the southern African species are not large enough to predict the frequencies with which these floating translocations occur in female plants, but there is no reason to assume they are not identical to those in the male plants, as previously demonstrated in an east African species, *V. hildebrandtii* (Wiens & Barlow, 1979). In that species the population from Riandu, Kenya, has male plants which all possess $\odot 6$ (the sex-associated complex), but some male plants have an additional $\odot 4$ and/or $\odot 6$. In the female plants these floating $\odot 4$ and $\odot 6$ were recorded as well as a homozygote with 14 II. This strongly supports our earlier suggestion (Barlow & Wiens, 1975) that in this group of dioecious *Viscum* there is one translocation ring which is sex-associated and fixed in males as the heterozygous sex, while the other rings are floating and not sex-associated.

In some respects the species in this group are chromosomally relatively uniform. With the exception of *V. subseriatum* ($n=11$), all species in the group have $n=14$ and a generally symmetrical karyotype. The most common sex-associated rings are $\odot 4$ and $\odot 6$, and in three species both rings are present. A floating $\odot 4$ is present in at least five of the six species.

TABLE 2.—Summary of chromosome constitutions in dioecious species of *Viscum* in southern Africa

[illegible]

A few differences are superimposed on this common pattern. A sex-associated $\odot 8$ occurs in *V. combreticola*, and in two additional species in eastern Africa (Wiens & Barlow, 1979). Its occurrence may be linked with the presence of a sex-associated $\odot 6$, which appears to be common in these three species. In *V. combreticola* there is also evidence for two independent floating $\odot 4$, and a floating $\odot 6$ occurs in *V. menyharthii*.

In this species group, then, the sex-associated complex consistently appears in males as $\odot 4$ and $\odot 6$, and in addition, most species have a floating $\odot 4$. This regular pattern suggests that the sex-associated translocations (and possibly also the floating ones) may be the same in most or all of the species in the group. If so, the translocation system may be relatively old and possibly established prior to the differentiation of the extant species. The accumulation of linked complexes through the translocations may have promoted rapid differentiation of biotypes, and the uniformity of chromosome number among these species is consistent with this possibility.

The second group includes the remaining four species which all have different chromosome numbers ($n=10, 12, 14, 15$). In these species some of the male plants produced only bivalents, indicating that fixed sex-associated complexes are not present. There is evidence, however, of extensive floating translocation heterozygosity, presumably in female plants as well as males, but additional data on this point are needed. In fact, floating translocations are apparently more frequent in this species group than in the first. In *V. oreophilum* two floating $\odot 4$ s occur, but *V. obscurum* contains the most extreme complexity, where associations up to $\odot 12$ exist, and individuals with two rings are relatively common. The minimum number of floating translocations needed to produce these associations in *V. obscurum* is five, assuming that all configurations observed represent recombinations of the same translocations.

Perhaps the species in this group represent a transitional stage in the evolution of the sex-associated translocation system, with the floating translocations acquired first and later linked with the sex-deter-

mining chromosomes by subsequent translocations. However, this group contains both highly specialized and diverse species as indicated by their morphology and range of chromosome numbers. They may, therefore, also represent a derived state in which sex-associated multivalents are released from linkage with the sex-determining chromosomes by subsequent translocations. These would then become floating multivalents. This hypothesis is consistent with the observation that the species in this group have a greater diversity of floating multivalents than the species in the preceding group. In other words, sex-associated multivalents were possibly acquired early in the evolution of the genetic system, and later converted to floating associations by subsequent exchanges. This appears to us as the best explanation and is discussed further.

A third class of translocation heterozygosity occurs in African *Visca*, but it is limited to the single species, *V. fischeri*, which is geographically restricted to eastern Africa. This translocation system was described earlier in this paper and extensive discussion of this translocation system is unnecessary and it is mentioned here only for conceptual completeness. This species is unique in having different chromosome numbers in males and females and also unusual in its uniformity, having the same sex-associated multivalent in all male plants examined, and no floating multivalents in either sex.

Frequencies of floating translocations

The data indicate that the frequencies of floating translocations vary between populations in some species. Estimates of the frequencies of floating $\odot 4$ for a few species in which some analysis is possible are given in Table 3.

In *V. verrucosum* the frequency of the heterozygote with the floating $\odot 4$ may vary significantly between populations, from zero to the theoretical maximum of 0.5, with corresponding variations in gametic frequencies of the translocation complexes. Similar variations appear to occur in some of the other species listed. However, because of the small sample sizes it is not possible to determine the frequencies

TABLE 3.—Frequencies of floating $\odot 4$ in southern African species of *Viscum*

Species	Locality (for details see Appendix)	No. of plants sampled	No. of plants with floating $\odot 4$	Frequency of heterozygotes	Estimated gametic frequency of translocation	Heterogeneity	
						χ^2	P
<i>V. capense capense</i>	Cape Peninsula	14	8	0.57	0.50*	8.69	<0.005**
<i>V. capense hoolei</i>	Grahamstown	8	1	0.13	0.07	f=1	
<i>V. crassulae</i>	King William's Town 29-37 km N of Grahamstown	8	0	0.00	0.00	5.35	<0.025**
		15	7	0.47	0.37	f=1	
<i>V. subserratum</i>	Ntokweni	8	2	0.25	0.15		
	Duiwelskloof	8	2	0.25	0.15	1.27	0.5
	Mkuze	11	5	0.45	0.35	f=1	
<i>V. verrucosum</i>	Duiwelskloof	8	5	0.63	0.50*		
	Soutpan	16	1	0.06	0.03		
	Mkuze	12	0	0.00	0.00	18.9	<0.005**
	Kranzkop	14	3	0.21	0.12	f=4	
	Siteki	13	7	0.54	0.50*		

* theoretical maximum.

** significant at $p < 0.025$.

TABLE 4.—Sex ratios in some dioecious southern African species of *Viscum*

Species	Locality (for details see Appendix)	No. of plants		Sex ratio	χ^2 exp. 1.00	χ^2 exp. 0.75
		Male	Female			
<i>V. anceps</i>	12 km W of Port St Johns	12	11	1.09	0.04	
<i>V. capense</i>	Cape Peninsula	133	110	1.21	2.18	
<i>V. continuum</i>	Calitzdorp	9	11	0.82	0.20	
	De Rust	28	33	0.85	0.41	
	Oudtshoorn	59	60	0.98	0.00	
	Laingsburg	54	47	1.15	0.49	
	Worcester	16	19	0.84	0.26	
	Bonnievale	29	48	0.60	4.69*	
	Stormsvlei	13	14	0.93	0.02	
		208	232	0.90	1.30	
<i>V. crassulae</i>	King William's Town	10	6	1.67	0.50	
<i>V. menyharthii</i>	Wyliespoort	22	19	1.16	0.22	
<i>V. obscurum</i>	Pretoriusskop	5	6	0.83	0.09	0.03
	King William's Town	29	28	1.04	0.02	1.52
	Grahamstown	44	70	0.63	5.93*	0.86
	Avontuur	39	48	0.81	0.93	0.16
		117	152	0.77	4.55*	0.05
<i>V. subserratum</i>	Ntokweni	36	49	0.73	1.99	0.01
	Mkuze	31	42	0.74	1.66	0.00
		67	91	0.74	3.65	0.01
<i>V. verrucosum</i>	Duiwelskloof	63	58	1.09	0.21	
	Soutpan	16	24	0.67	1.60	
	Mkuze	39	52	0.75	1.86	
	Kranzkop	52	44	1.18	0.67	
		170	178	0.96	0.18	

* $p < 0.05$.

with high levels to confidence, and the calculated frequencies in Table 4 can only be regarded as a general indication of the scale of variation.

If the high frequencies of heterozygosity recorded for some populations are real, then positive selection favouring the heterozygotes is indicated. If the translocation complexes maintain adaptive gene combinations, there must be interaction between suites of genes in the complementary chromosome complexes, thus generating heterozygote advantage. Bloom (1977) has shown in *Clarkia* that translocation heterozygosity is maintained because of the levels of inbreeding which might be imposed on natural populations. This argument could apply to *Viscum*, which is a generally host-specific parasite, often occurring in small, relatively isolated local populations probably derived from a few founder individuals.

Supernumerary chromosomes

A single supernumerary (B-) chromosome was observed in some individuals in a few of the dioecious species. In *V. verrucosum*, the B-chromosome was recorded from several populations throughout the range of the species in South Africa, and occurred in approximately half the plants sampled from each population in which it was found. The B-chromosome in this species was visible at meiotic metaphase as a small rounded unit usually just off the equatorial plate. Earlier in prophase it showed a constriction near one end, indicating it was acrocentric. The B-chromosome usually moved undivided to one pole at first anaphase and divided at second anaphase, and was thus transmitted to two of the four pollen grains. Occasionally it lagged at first anaphase, and

the elimination of the B-chromosome may be correlated with the occurrence of a small microcyte present in less than 10 per cent of tetrads. In some cases the B-chromosome in *V. verrucosum* appeared to be associated with aberrations in the A-chromosomes. Sometimes one bivalent did not orient at first metaphase, behaving as if it were monocentric. In other cases chromosome fragmentation appeared to occur in cells carrying the B-chromosome.

In *V. capense* from the Springbok area the B-chromosome was of similar shape and behaviour to that in *V. verrucosum*, except it was larger. In *V. obscurum* a B-chromosome was observed in only one population, but it was much larger than those observed in any other species. Thus different species appear to have distinctive B-chromosomes. In addition, at least three different B-chromosomes are widespread over the range of *V. album* in Europe and Asia (Barlow *et al.*, 1978; Barlow & Wiens, unpublished data), suggesting they have a regular behaviour which ensures their persistence.

Although B-chromosomes in *Viscum* may be confined to the dioecious species, it is unlikely that they have a direct association with the dioecious state. Since the dioecious species are also characterized by high frequencies of translocations, it seems likely that the B-chromosomes have originated as centric fragments resulting from chromosome breakage, reunion and segregation. Such an origin has been suggested for other groups of plants (John, 1976; Darlington, 1974; Jackson, 1960) and particularly for *Clarkia*, where B-chromosomes may arise *de novo* rather frequently in populations with high levels of translocation heterozygosity (Wedberg *et al.*, 1968).

Sex ratio

The data on sex ratio are summarized for several species in Table 4. Sample sizes are occasionally relatively small, due to the difficulty of collecting some species. A few species of *Viscum* have deviations from a sex ratio of unity. An excess of female plants was previously recorded for *V. fischeri* in east Africa (sex ratio 0.52; Barlow & Wiens, 1976). In *V. obscurum* the total for all samples deviates significantly from an expectation of unity, and the individual samples are homogeneous and consistent with a female predominant sex ratio of about 0.75. A similar excess of female plants may occur in *V. subseriatum*, although the populations sampled gave results just within the level of significance. The only case of a possible excess of male plants is in the east African species, *V. hildebrandtii* where the sex ratio may be about 1.4 (Barlow & Wiens, 1975).

In most cases, however, the data agree with a sex ratio of 1.0, and where more than one population of a species was sampled, the data appear to be homogeneous. The biased sex ratio first observed in *V. fischeri* therefore does not appear to be a general feature of the African species. No other species examined from Africa shows the distortion to the same degree, either in favour of male or female plants.

In *V. fischeri* we originally suggested that the biased sex ratio might be due to the sex-associated translocation heterozygosity, with the two translocation complexes having different transmission rates through the pollen. We believed this might be the principal rôle of the translocation heterozygosity in this species. The patterns obtained in southern Africa now indicate that this explanation is unlikely, since there is no regular relationship between sex ratio and translocation heterozygosity. If the translocations have a rôle in the maintenance of biased sex ratios, it is probably a secondary function of the translocation system and is established only in those species in which distortion of the sex ratio may be of significance for other reasons. Situations in which biased sex ratios might be favoured in plants are described by Bawa & Opler (1977), Mulcahy (1967) and Kaplan (1972). In *Viscum* an excess of females might achieve maximum seed set in populations which are space-limited, efficiently pollinated, and perhaps subject to heavy seed predation. An excess of male plants may be favoured in open situations where pollination efficiency might be limited by the distance between male and female plants.

DISCUSSION

This survey shows that translocation heterozygosity occurs in all the dioecious species of *Viscum* in southern Africa, but is apparently rare among the monoecious species. Since the dioecious species *V. album* L. and *V. cruciatum* Boiss. in Europe and Asia, and *V. alniformosanae* Hayata in Taiwan show patterns of translocation heterozygosity similar to the African species (Barlow *et al.*, 1978; unpublished data), this relationship probably extends to all dioecious members of the genus. The only remaining area rich in dioecious species of *Viscum*, which is not well surveyed, is Madagascar. The Madagascan species, as opposed to the African ones, are apparently based predominantly on $x=13$ instead of $x=14$ (Wiens, 1975), but there is little reason to suspect that their genetic systems are different.

The translocation heterozygosity in *Viscum* thus emerges as a phenomenon which is characteristic of the dioecious state. As suggested above, some of the translocations may be common to several species, and the translocation systems were possibly established prior to, or during the differentiation of related species. The translocations, in fact, may have played a fundamental rôle in the establishment of dioecy in the genus.

There is little doubt that dioecy in *Viscum* is derived from monoecy. Unisexual flowers are characteristic of all Viscaceae, and monoecy is fixed or predominant in all genera. In most other respects, however, *Viscum* conforms with the observations or predictions of dioecy in tropical forests made by Bawa & Opler (1975). They concluded that dioecy evolved in response to selection for the enforcement of outcrossing, and suggested a number of factors which may have favoured dioecy as the outcrossing mechanism. These include (1) the likely genetic simplicity of dioecy compared with self-incompatibility (Baker, 1967), (2) high levels of reproductive failure in self-incompatible hermaphrodite or monoecious species because of the small foraging ranges of the pollen vectors, and (3) escape from seed predation caused by altered size and distribution of seed set. Possibly all of these factors have contributed to the evolution of dioecy in *Viscum*.

If dioecy is established by mutations affecting different hormone systems which favour maleness and femaleness (Audus, 1972; Bose & Nitsch, 1970), then such genes would likely be nonallelic. This possibility was argued on *a priori* grounds for angiosperms generally by Ross & Weir (1976) and Charlesworth & Charlesworth (1979). These authors also point out that mutations for dioecy are not likely to accumulate simultaneously, and that in many cases gynodioecy, through male sterility, is an intermediate step. If the genes for full dioecy were not linked, recombination could produce males, females, hermaphrodites and neuters, and Charlesworth & Charlesworth (1979) suggest there might often be a 'linkage constraint', such that unlinked genes for dioecy may be selected against. Thus genes for dioecy should occur on the same chromosome, with no crossing-over between loci, so that particular chromosomes become identified with sex determination. If these constraints apply in *Viscum*, then translocations should have a rôle in the evolution of dioecy, namely in bringing the nonallelic sex factors into close linkage. Our data suggest that in many species of *Viscum* dioecy is stabilized in this way, and that this system for maintaining dioecy is conserved during the differentiation of new species. The problem is discussed more fully elsewhere (Wiens & Barlow, 1979).

Even if this model for the evolution of dioecy in *Viscum* is correct, translocations are perhaps of further adaptive importance in the genus. Floating translocations are common even in species like *V. hildebrandtii* which retain the sex-associated multivalent, and they are also retained in species like *V. obscurum* which may have lost the sex-associated multivalent. Their persistence in high frequency indicates a more basic rôle in the genetic system of *Viscum*, presumably as a means of maintaining high levels of heterozygosity. But why have translocations accumulated only in dioecious species and not in monoecious species? Perhaps the fixation of translocation heterozygosity by sex-association allows time

Species	Monocious or Dioecious	Genetic chromo- some No.	Locality	No. and sex of plants	Configuration	Voucher or reference
<i>V. anceps</i> E. Mey. ex Sprague	D	14	SOUTH AFRICA: Natal: Oribi Gorge	1 m 1 m	111106 9110406	W5358b W5358a
			TRANSKEI: 27-38 km N of Port St. John	4 m 1 m 2 m	121104 111106 10110404	W5362a,c W5363 W5364b W5362d W5364a W5365
			TRANSKEI: 12 km W of Port St. John	3 m 1 m	121104 10110404	W5366b,d,g W5366a
			TRANSKEI: 23 km W of Butterworth	1 m	121104	W5368
<i>V. capense</i> L. f. subsp. <i>capense</i>	D	10	SOUTH AFRICA: Cape: Springbok	6 m	1011 ¹	W5413 W5414 W5416a-d
			SOUTH AFRICA: Cape: Garies	2 m	1011	W5412a,b
			SOUTH AFRICA: Cape: Cape Peninsula, from Chapman's Bay to Nature Res.	6 m 7 m 1 f	1011 81104 81104	82178a-c 82182a,e,i 82179a 82182a-c,f-h 82178d
<i>V. capense</i> L. f. subsp. <i>indolens</i> Wiens	M ²	10	SOUTH AFRICA: Cape: 7 km S of Prince Albert	1	tetraploid	W5402
			SOUTH AFRICA: Cape: 17 km S of Willowmore	3	1011	W5393 W5394a,b
			SOUTH AFRICA: Cape: 8 km NW of Grahamstown	7 1	1011 81104	W5385a,b,d-h W5385c
<i>V. combreticola</i> Engl.	D	14	SOUTH AFRICA: Transvaal: 18 km E of Waterpoort	2 m	111106	W5316a,c
			SOUTH AFRICA: Transvaal: 9 km W of Zoutpansberg summit	1 m	111106	W5313b
			SOUTH AFRICA: Transvaal: N of Middle- burg near Tigerpoort	1 m 1 m	101108 611040408	W5271e W5271a
			SOUTH AFRICA: Transvaal: Hartbeest- poort	1 m	711040406	W4672
<i>V. continuum</i> E. Mey. ex Sprague	D	14	SOUTH AFRICA: Cape: 26 km W of Komga	3 m	121104	W5371a-c
			SOUTH AFRICA: Cape: 9 km E of Fort P. aufort	5 m 2 m	121104 10110404	W5377a,c-e,g W5377b,f
			SOUTH AFRICA: Cape: 4 km E of Calitzdorp	6 m	121104	W5397a-f
			SOUTH AFRICA: Cape: De Rust	5 m 1 m	121104 111106	W5398a-c,e,f W5398d
			SOUTH AFRICA: Cape: 4 km N of Oudtshoorn	6 m 1 m	121104 10110404	W5400a,b,d-g W5400c
			SOUTH AFRICA: Cape: 7 km S of Prince Albert	3 m 2 m	121104 10110404	W5401a-c W5401d,e
			SOUTH AFRICA: Cape: 68 km E of Laingsburg	6 m	121104	W5403a-f
			SOUTH AFRICA: Cape: 16 km S of Worcester	8 m	121104	W5405a-h
			SOUTH AFRICA: Cape: 20 km S of Bonnievale	6 m	121104	W5406a-f
			SOUTH AFRICA: Cape: 13 km N of Stormsvlei	6 m	121104	W5408a-f
<i>V. crassulae</i> Eckl. & Zeyh.	D	12	SOUTH AFRICA: Cape: 74 km SW of King Williams Town	8 m	1211	W5373a-e,g,i,j
			SOUTH AFRICA: Cape: Committee Drift be- tween Grahamstown and Fort Beaufort	4 m	1211	W5376a-c,f
			SOUTH AFRICA: Cape: Ecce Pass NE of Grahamstown	4 m	1211	W5378a,e-g
			SOUTH AFRICA: 29-37 km N of Grahamstown	7 m 7 m 1 m	1211 101104 91106	W5379b,c,f,h, W5381a,b,d W5379a,d,e,g,i,j W5381c W5381e
<i>V. meyertharii</i> Engl. & Schinz	D	14	SOUTH AFRICA: Cape: Near Addo	2 m	1211	W5386a,b
			SOUTH AFRICA: Cape: Hankey	1 m	1211	W5388a
			SOUTH AFRICA: Cape: Near Patensie	2 m	1211	W5389 W5390
			RHODESIA: 73 km S of Karoi	1 m 1 m	111106 10110404	W4628a W4628b
			SOUTH AFRICA: Transvaal: Wylliespoort	2 m 6 m 4 m 2 m 1 m 2 f	121104 111106 9110406 711040406 611040606 1411 121104	W485431d,g W485431a,b,f,i,k,r W485431j,n-p W485431m,q W485431r W485431h W485431c,e
<i>V. minimum</i> Harv.	M	14	SOUTH AFRICA: Cape: 8 km NW Grahamstown	1	1411	W5375
<i>V. nervosum</i> Hochst. ex. A. Rich.	M	14	SOUTH AFRICA: Transvaal: 16 km W of Shina-alongubodam	1	1411	W5262
<i>V. obovatum</i> Harv.	M	12	SWAZILAND: Near Forbes Reef	1	1411	W5461
			SOUTH AFRICA: Natal: Mkuze Game Reserve	2	1211	W5274 W5275
			SOUTH AFRICA: Natal: 2 km N of Jozini	1	1211	W5280
			South Africa: Natal: 13-14 km SW of Jozini	2	1211	W5278 W5283
<i>V. obscurum</i> Thunb.	D	15	SOUTH AFRICA: Transvaal: Near Nyamondra Dam 30 km NE of Pretoriuskop	3 m 1 m 1 m 1 f	1511 131104 1011010 9110408	W485424a,j,i W485424k W485424g W485424i
			SOUTH AFRICA: Natal: Near Thousand Hills Valley	2 m 1 m 1 m	1511 1011010 9110408	W5293 W5356c W5356a W5356b
			SOUTH AFRICA: Cape: 28 km W of King Williams Town	1 m 3 m 1 m	1511 131104 10110406	W5372d W5372a,c,e W5372b
			SOUTH AFRICA: Cape: 22 km W of Komga	3 m	131104	W5369a-c
			SOUTH AFRICA: Cape: 8 km NW of Grahamstown	2 m 1 m 2 m 1 m	131104 11110404 10110406 9110408	W5384a,b W5384c W5384d,k W5384l W5384g
			SOUTH AFRICA: Cape: Addo	1 m 1 m 2 m	1511 121106 10110406	W5387b W5387d W5387a,c
			SOUTH AFRICA: Cape: 28 km S of Avontuur	3 m 2 m 1 m	1511 131104 11110404	W5395d,i,j W5395a,k W5395e
<i>V. oreophilum</i> Wiens	D	14	SWAZILAND: Buttermworth	2 m	11110404	W5367a,b
			SOUTH AFRICA: Transvaal: Ebbe Dam	1 m	1411	W5344
			SOUTH AFRICA: Transvaal: 7 km W of Zoutpansberg summit	1 m	1411	W5311
<i>V. pauciflorum</i>	M	14	SWAZILAND: Near Forbes Reef	1 m	111106	W5462
			SWAZILAND: Mbabane	1 m 5 m	1411 10110404	W5459c W5458b,h,j W5459i
			SOUTH AFRICA: Cape: ca 12 km NE of Worcester	1	1411	W4653
<i>V. rotundifolium</i> L. f.	M	14	RHODESIA, SOUTH AFRICA	3	1411	Wiens, 1975
			SOUTH AFRICA: Transvaal: Near Tshipise	1	1411	W5320
			SOUTH AFRICA: Transvaal: Pretoria	17	1411	W5436a-i, 1 W5436a-d,g,h,i
<i>V. spragueanum</i> Burt Davy	M	23	SOUTH AFRICA: Transvaal: 12 km S of Silberman's Post	1	2311	W5295
<i>V. subseriatum</i> Schlecht.	D	11	SOUTH AFRICA: Transvaal: Kruger Park 2 km E of Ntokweni Range Station	6 m 2 m 2 f 1 f	911104 71110404 1111 911104	W485427b,d,g,i,k W485427a,h W485427m,n W485427l
			SOUTH AFRICA: Transvaal: 34.5 km E of Nelspruit	2 m	911104	W5255a,c
			SOUTH AFRICA: Transvaal: 46-49 km SW of Duivelskloof	5 m 1 m 2 m	911104 811106 71110404	W5305c-e,h W5307 W5305f W5305a,b
<i>V. verrucosum</i> Harv.	D	14	SOUTH AFRICA: Natal: Between Mkuze and Magadu	6 m 5 m	911104 71110404	W5287e,g,h,j W5290a,b,d W5287b-d,f,i
			SOUTH AFRICA: Transvaal: 9 km E of Punda Milla	2 m	121104 ¹	W526a,b
			SOUTH AFRICA: Transvaal: between Loui's Trichardt and Messina	2 m 2 m	121104 ¹ 10110404	W5326a,c W5326b,d
			SOUTH AFRICA: Transvaal: 50 km SW of Duivelskloof	2 m 1 m 4 m 1 m	121104 111106 10110404 91110406	W5304e,g W5304d W5304b,c,f,j W5304a
			SOUTH AFRICA: Transvaal: between Loui's Trichardt and Pietersburg	1 m	121104	W485434c
			SOUTH AFRICA: Transvaal: 5 km S of Steelpoort	1 m	111106 10110404	W5270e W5270b
			South Africa: Transvaal: near Zoutpan Experimental Farm	15 m	121104 ¹	W5298a-c W5299a,b,d
			SOUTH AFRICA: Natal: between Mkuze and Magadu	8 m 4 m	121104 ¹ 111106 ¹	W5438a-i W5298d
			SOUTH AFRICA: Natal: Tugela Ferry	3 m 2 m	121104 10110404	W5284a-i W5284g,j-i
			SOUTH AFRICA: Natal: 38 km N of Kranskop	11 m 3 m 1 m	121104 10110404 triploid	W5351a,b,e W5351c,d W5355a,b,d-k,m W5355c,i,o W5355n
			SWAZILAND: 27-32 km W of Siteki	4 m 2 m 7 m	121104 ¹ 111106 10110404 ¹	W5266c W5269b,c,n W5269a,d W5266b,e-g W5269e,g,i

¹ Supernumerary chromosomes also present (see text)² Monoecy is atypical (see text)

for the accumulation of adaptive gene combinations in the translocation complexes, thus giving them immediate selective value when released as floating translocations. Such complexes would have more likelihood of being conserved than raw exchanges directly exposed to selection, as would be the case in monoecious species.

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UITTREKSEL

Geslagsgekoppelde en drywende translokasiekomplekse is kenmerkend van tweehuisige (diësiëse) Viscum-spesies, maar is feitlik afwesig in die eenhuisige spesies. Die meerderheid tweehuisige spesies het vasgelegde translokasiekomplekse wat geassosieerd is met geslagsbepaling; met die manlike geslag die heterogametiese geslag. Die geslagsmultivalente is gewoonlik 'n ring van vier $\odot 4$ of $\odot 6$, maar soms $\odot 8$. Tweehuisige spesies sonder geslagsgekoppelde translokasies kom baie selde voor. Die meeste tweehuisige spesies is ook polimorfies vir drywende translokasie deurdat een of meer addisionele multivalente kan voorkom, wat wissel van $\odot 4$ tot $\odot 12$.

Drywende translokasies word meer dikwels aangetref in spesies wat nie geslagsgekoppelde translokasies besit nie. Bi-chromosome is ook teenwoordig in verskeie spesies. Die verhouding manlike tot vroulike spesies is gelyk in die meeste tweehuisige spesies, maar hierdie verhouding mag verskuif; meer in die guns van die vroulikes in sommige spesies. Die hoë korrelasie tussen tweehuisigheid en translokasieheterosigositeit is 'n aanduiding dat translokasies primêr geassosieerd is met die oorsprong en vestiging van tweehuisigheid. Enige rol in die afwyking van die verwagte verhouding manlikes tot vroulikes deur "mitotic drive", is heel waarskynlik sekondêr. Geslagsgekoppelde translokasies mag tweeslagtigheid stabiliseer, deurdat dit die geslagsfaktore in noue koppeling bring. Daaropvolgende strukturele herrangskikkings binne geslagsgekoppelde translokasiechromosome mag die geslagsfaktore

geneties koppel in een chromosoompaar, met die totstandkoming van drywende translokasies. Die hoë frekwensie van drywende translokasieheterosigositeit in sommige spesies dui aan dat sulke heterosigositeit ook voordelig in die plante is.

REFERENCES

- AUDUS, L. J., 1972. *Plant growth substances*. London: Leonard Hill.
- BAKER, H. G., 1967. Support for Baker's Law—as a rule. *Evolution* 21: 853–856.
- BARLOW, B. A. & WIENS, D., 1975. Permanent translocation heterozygosity in *Viscum hildebrandtii* Engl. and *V. engleri* Tiegh. (Viscaceae). *Chromosoma* (Berl.), 53: 265–272.
- BARLOW, B. C. & WIENS, D., 1976. Translocation heterozygosity and sex ratio in *Viscum fischeri*. *Heredity* 37: 27–40.
- BARLOW, B. A., WIENS, D., WIENS, C., BUSBY, W. H. & BRIGHTON, C. 1978. Permanent translocation heterozygosity in *Viscum album* and *V. cruciatum*: sex association, balanced lethals, sex ratios. *Heredity* 40: 33–38.
- BAWA, K. S. & OPLER, P. A., 1975. Dioecism in tropical forest trees. *Evolution* 29: 167–179.
- BAWA, K. S. & OPLER, P. A., 1977. Spatial relationships between staminate and pistillate plants of dioecious tropical forest trees. *Evolution* 31: 64–68.
- BLOOM, W. L., 1977. Translocation heterozygosity, genetic heterozygosity, and inbreeding in *Clarkia speciosa*. *Evolution* 31: 256–264.
- BOSE, T. K. & NITSCH, J. P., 1970. Chemical alteration of sex expression in *Luffa acutangula*. *Physiologia Pl.* 23: 1206–1211.
- CHARLESWORTH, B. & CHARLESWORTH, D., 1979. A model for the evolution of dioecy and gynodioecy. *Amer. Nat.* (in press).
- DANSER, B., 1941. The British-Indian species of *Viscum* revised and compared with those of South-Eastern Asia, Malaysia and Australia. *Blumea* 4: 261–319.
- DARLINGTON, D. D., 1974. *Chromosome botany*. London: Allen and Unwin.
- JACKSON, R. C., 1960. Supernumerary chromosomes in *Haploppappus gracilis*. *Evolution* 14: 135.
- JOHN, B., 1976. *Population cytogenetics*. London: Edward Arnold.
- KAPLAN, S. M., 1972. Seed production and sex ratio in anemophilous plants. *Heredity* 28: 281–285.
- MULCAHY, D. L., 1967. Optimal sex ratio in *Silene alba*. *Heredity* 22: 411–423.
- MULLER, J., 1925. Why polyploidy is rarer in animals than plants. *Amer. Nat.* 59: 346–353.
- ROSS, M. D. & WEIR, B. S., 1976. Maintenance of males and females in hermaphrodite populations and the evolution of dioecy. *Evolution* 30: 425–441.
- WEDBERG, H. L., LEWIS, H. & VENKATESH, C. S., 1968. Translocation heterozygotes and supernumerary chromosomes in wild populations of *Clarkia williamsonii*. *Evolution* 22: 93–107.
- WIENS, D., 1975. Chromosome numbers in African and Madagascar Lorantheaceae and Viscaceae. *Bot. J. Linn. Soc.* 71: 295–310.
- WIENS, D. & BARLOW, B. A., 1973. Unusual translocation heterozygosity in an East African mistletoe (*Viscum fischeri*). *Nature New Biol.* 243: 93–94.
- WIENS, D. & BARLOW, B. A., 1975. Permanent translocation heterozygosity and sex determination in East African mistletoes. *Science* 187: 1208–1209.
- WIENS, D. & BARLOW, B. A., 1979. Translocation heterozygosity and the origin of dioecy in *Viscum*. *Heredity* 42 (in press).
- WIENS, D. & TÖLKEN, H. R., 1979. Viscaceae. In O. A. Leistner, *Flora of Southern Africa*. 10,1: 1–59.

Field identification of roots of woody plants of the savanna ecosystem study area, Nylsvley

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ABSTRACT

A key for the field identification of fresh root material of 21 woody plant species on the savanna ecosystem study area, Nylsvley, South Africa, is given. Descriptions of macroscopic features of roots as well as photographic descriptions of roots and root systems are provided.

RÉSUMÉ

IDENTIFICATION SUR LE TERRAIN DE RACINES DE PLANTES LIGNEUSES DANS LA RÉGION DE L'ÉCOSYSTÈME DE SAVANE ÉTUDIÉ À NYLSVLEY

On donne une clé pour l'identification sur le terrain de matériel racinaire frais concernant 21 espèces de plantes ligneuses rencontrées dans la zone d'étude d'un écosystème de savane à Nylsvley en Afrique du Sud. Les caractères macroscopiques des racines sont décrits et l'on y joint des photographies des racines et des systèmes racinaires.

INTRODUCTION

During the course of root investigations in the *Burkea africana*-dominated savanna of the South African savanna ecosystem project study area on the Nylsvley Nature Reserve in the northern Transvaal, the need for species identification of roots has frequently arisen. In the nutrient-poor, often deep (> 2 m) sandy soil of this area, it has been found that roots of woody plants often extend well beyond the tree canopy's ground projection area. In some species the lateral roots commonly extend linearly up to seven times the extent of the canopy, that is, an area about 50 times the area covered by the canopy. The roots of some species do not often radiate symmetrically from the stem position, but may all lie to one side of this position, for example, sometimes in *Ochna pulchra*. The result is often a relatively high degree of different species root interpenetration (interdigitation) that is usually extremely difficult to predict from only a study of the distribution of the aboveground parts of the species. Species identification of roots is needed to increase the quality of root data derived from techniques including soil core and block or monolith sampling. Identification is also important when exposing entire root systems for determination of root distribution and biomass distribution of a limited set of species. Here positive identification is needed to 'weed out' roots of other species that occur in between the roots of the species under study as field work proceeds. Because many tons of soil would often need to be carefully removed to trace a particular root to its parent plant stem for identification, and more importantly since it has been found that it is usually impracticable to trace roots of several species simultaneously without destroying some of the roots that are still required, root identification based on easily observable characteristics in relatively small root samples is required.

The drawing up of keys to identify roots to the species based on macroscopic features in the field appears to have been seldom attempted. One work that has been found provides a key for the identification of roots of 11 conifer species in certain forest areas of north-western America (Gilbertson *et al.*,

1961). These workers report not finding any reference to such identification prior to their work. One of the great problems, also found by the above quoted writers, is that diagnostic characteristics for species identification of roots tend to disappear on small-diameter roots. Another factor that has undoubtedly discouraged devising field root identification keys is that below ground plant organs are usually far less clearly differentiated compared to the high degree of above ground plant organ differentiation that provides many possible diagnostic features for clear identification. Most taxonomic works on woody plant species seldom contain descriptions of roots. Although microscopic features undoubtedly provide much more information for root identification, such features are usually impracticable for use in rapid field identification.

In the present study, description of species roots is limited to roots usually greater than 5 mm in diameter. The species that were included were selected on the basis of a plant ecological survey carried out by Coetzee *et al.* (1976) on the site. All woody species that occurred with a frequency of > 20% in their defined "*Eragrostis pallens*—*Burkea* Tree Savanna" were included. Their sample plots were so large (each about 0,8 ha) that some of the species with a frequency of > 20% were not common. The 19 species included were therefore not limited to the most common species. Since two species (*Lannea edulis* and *Fadogia monticola*) with a frequency of just under 20% but probably in smaller plots of 0,02 ha, are known despite their non-woody above-ground habit to have large and extensive woody below-ground organs, these two species were also included resulting in a total species number of 21. These species also included those 11 species which together constituted more than 98% of the total above-ground woody plant biomass of the site (Rutherford, 1979). Since not all woody species are included, however, it is possible that in some situations, roots of other species may be present. Therefore inspection for above-ground evidence of rarer excluded species should be done and the roots of such species first examined to prevent misidentification using the key. This principle will obviously also apply when using the key in other similar *Burkea africana* communities. In the event of a particular difficulty arising when using the key, it should be borne in mind that often several species

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may be eliminated on their absence (viewed on above-ground evidence) within a radius of about 50 m from the sampling point.

Not all underground organs are roots, for example, the underground stems of *Fadogia monticola* and some other "rhizomatous" geoxylic suffrutices (White, 1976). To avoid the cumbersome repetition of "underground organ", the term "root" is used instead to indicate that part of the plant below the soil surface. After much secondary thickening has taken place, the difference between root and underground shoot becomes much reduced, so that particularly from a functional viewpoint, these two organ types may be regarded as much alike. Pith refers to the apparent original centre of growth in the root. Outer bark refers to the outer, dry and usually very thin, layer around the root. Inner bark refers to the rest of the bark and is distinguished by being moister and usually much thicker than the outer bark. In the key and descriptions, bark thickness (sum of two bark thicknesses over total root diameter) given is for roots further away from the stem position and not necessarily for the very thick roots near the plant base. Often in fresh root cross sections, pores are not visible or scarcely visible but, upon drying out (for example, in some of the photographs given), become clearly visible sometimes together with rays and rings. All cross section views (cut with pruning shears) and surface views in the photographs are of roots between 1–3 cm diameter. The root system views are scaled with a pole marked off in 10 cm divisions. The degree of tap root development indicated in some of the photographs depends upon the age of the individual. In smaller younger trees, tap roots are usually prominent, but in larger, older trees lateral and heart roots in most species develop far more than does the tap root. In the selection of root systems for photographing, juvenile individuals were avoided. Each root system was exposed by first removing all soil and roots vertically up to a point 30 cm in front of the stem(s) position, then using water under pressure to remove all soil up to a point immediately below the stem(s) and half a metre on each side of the (main)

stem and down to about one metre depth. All roots of other species were pruned from this region. The photographs are only intended to give on a standard comparative basis, the type of root system in the immediate area of the stem base and in most cases only represents a very small proportion of the whole root system.

The roots of certain species are very variable in appearance and are sometimes keyed out more on negative characters than on positive characters. One character that may be particularly variable is the intensity (and pattern) of the colour of the outer bark, which often depends on the moisture content of the soil at the time of sampling. In a few species the inner bark or wood of the roots changes colour markedly after a relatively short period of exposure. Such characters have been employed in the key, although this inevitably implies that only totally fresh root material can be identified and that there are built-in time delays while using the key and inspecting for time-dependent colour changes. The key and descriptions do not apply to dead roots.

The following species are listed and are listed alphabetically:

1. *Burkea africana* Hook. (Caesalpinioideae)
2. *Combretum molle* R. Br. ex G. Don (Combretaceae)
3. *Combretum zeyheri* Sond. (Combretaceae)
4. *Dichapetalum cymosum* (Hook.) Engl. (Dichapetalaceae)
5. *Dichrostachys cinerea* (L.) Wight & Arn. (Mimosoideae)
6. *Dombeya rotundifolia* (Hochst.) Planch. (Sterculiaceae)
7. *Euclea natalensis* A. DC. (Ebenaceae)
8. *Fadogia monticola* Robyns (Rubiaceae)
9. *Grewia flavescens* Juss. (Tiliaceae)
10. *Lannea discolor* (Sond.) Engl. (Anacardiaceae)
11. *Lannea edulis* (Sond.) Engl. (Anacardiaceae)
12. *Ochna pulchra* Hook. (Ochnaceae)
13. *Ozoroa paniculosa* (Sond.) R. & A. Fernandes (Anacardiaceae)
14. *Parinari capensis* subsp. *capensis* Harv. (Chrysobalanaceae)
15. *Pygmaeothamnus zeyheri* (Sond.) Robyns (Rubiaceae)
16. *Securidaca longipedunculata* Fresen. (Polygalaceae)
17. *Strychnos cocculoides* Bak. (Loganiaceae)
18. *Strychnos pungens* Soler. (Loganiaceae)
19. *Terminalia sericea* Burch. ex DC. (Combretaceae)
20. *Vitex rehmannii* Guerke (Verbenaceae)
21. *Ximenia caffra* Sond. (Olacaceae)

Field key to roots of woody species

1. Bark emits readily recognizable odour of menthyl salicylate (oil of wintergreen)..... 16. *Securidaca longipedunculata*
Bark has no discernible odour of menthyl salicylate..... 2
2. Outer bark consists of very corky ridges..... 17. *Strychnos cocculoides*
Outer bark not markedly corky..... 3
3. Bark exudes copious amounts of white latex when cut..... 13. *Ozoroa paniculosa*
Bark not exuding white latex when cut..... 4
4. Bark papery in very loose multi-layered shedding, pale cream (not brown) layers... 5. *Dichrostachys cinerea*
Bark not papery in very loose multi-layered shedding pale cream layers..... 5
5. Inner bark a bright orange colour (not reddish) especially when outer bark lightly scratched away with thumbnail..... 3. *Combretum zeyheri*
Inner bark not a bright orange colour..... 6
6. Inner bark with uniformly smooth texture in cross section appears yellowish green colour, often becoming a deeper green colour after about one minute exposure. Thumbnail scratch colour not pink to red..... 20. *Vitex rehmannii*
Green not the predominant colour of the inner bark..... 7
7. Inner layer or all layers of inner bark deep yellow with the inner bark easily stripped in long extremely tough fibrous lengths (virtually unbreakable by hand tension)..... 19. *Terminalia sericea*
Inner bark not deep yellow and not extremely tough..... 8
8. Wood pithy and loose grained and often presenting a speckled appearance in cross section..... 18. *Strychnos pungens*
Wood not pithy and not speckled in cross section..... 9
9. Light yellow colour of inner bark and wood in cross section changes to deep intense yellow very rapidly within half to one minute after exposure. This deep yellow colour is then in characteristically strong contrast to the very dark outer bark..... 7. *Euclea natalensis*
Inner bark and wood do not clearly change to a deep yellow colour within half to one minute after exposure..... 10
10. Wood in cross section has very characteristic alternation of light yellow and dark yellow wedges..... 4. *Dichapetalum cymosum*
Wood in cross section does not have characteristic alternation of light and dark coloured wedges..... 11

11. Markedly eccentric radial growth often present (test at several spots on the root sample) with the pith often on the extreme edge of the wood. Wood cross section with alternating clear lighter and darker yellow bands (not thin rings), outerbark very dark brown often with reticulate striations, or grooved
Radial growth usually not extremely eccentric and no alternating bands in wood cross section and outerbark not very dark brown. 9. *Grewia flavescens* 12
12. Non-continuous orange strands set amongst yellowish (not reddish) tissue visible when deep scratches are made through the outer bark well into the inner bark. 15. *Pygmaeothamnus zeyheri*
Orange strands set amongst yellow tissue not visible in deep scratches into the inner bark. 13
13. Outer and inner bark together extremely thin. 14
- Outer and inner bark together not extremely thin. 15
14. Protrusions on outer bark in whorls of three and all lying in the same direction longitudinally. 8. *Fadogia monticola*
If outer bark protrusions present, not in whorls of three. 2. *Combretum molle*
15. Roots usually distinctly contorted, outer bark light brown to reddish brown and easily visible fine alternating radial lines of lighter and darker yellow in cross section of the very close grained wood. 12. *Ochna pulchra*
Roots seldom contorted and outer bark not light brown to reddish brown and fine alternating radial lines of lighter and dark yellow in cross section of wood not easily visible. 16
16. Inner surface of inner bark (at cambium layer) seen when bark partially stripped away from wood clearly changes from whitish to a deep brownish yellow within three minutes of exposure. 6. *Dombeya rotundifolia*
Inner surface of inner bark not clearly changing from whitish to deep brownish yellow within three minutes of exposure. 17
17. Outer bark overall colour whitish grey (not cream) with brown blotches, roots may be contorted. Woody cambium layer often markedly striated, almost furrowed. Appearance of pores in wood cross section are often characteristic. 14. *Paranari capensis*
Outer bark not lighter than a creamish colour; if whitish usually without very obvious regular pattern of lenticellular structures; wood at cambium layer usually not markedly striated so as to almost form furrows 18
18. Bark thickness > 25% of root diameter; inner bark fleshy with relatively high water content. 19
- Bark thickness < 25% of root diameter; inner bark not particularly fleshy. 1. *Burkea africana*
19. Inner bark thick and rubbery and bark will not strip in long lengths but breaks off leaving clear yellow or orange fibres extending from inner half of inner bark. 21. *Ximenia caffra*
Inner bark not rubbery and bark will peel in long lengths. 20
20. Bark often peels closely away from wood; outer bark often cracking in large block shapes; Pale tan coloured lenticellular structures often present on outer bark; pith often softer than remainder of wood. 11. *Lannea edulis*
Bark often starts to peel cleanly away from the wood but then leaves behind some innerlayered bark attached to the wood; outer bark seldom cracking in block shapes; lenticellular structures rare or absent; pith usually not softer than rest of wood. 10. *Lannea discolor*

1. *Burkea africana* Hook. (Figs 1 & 2)

Outer bark: Dark brown to cream; lenticellular structures often present and then scattered fairly evenly over bark and are a darker colour than most of the background. When bark is dark brown it often has a reticulate pattern of lighter and darker parts. When root is cream, bark is usually smoother but with many large lenticellular structures almost always present. There is a full gradation between these two root appearances. **Inner bark:** White on thin roots (<1 cm diameter) through light salmon pink to purple pink but a very pale colour on the innermost parts.



FIG. 1.—Root system of a *Burkea africana* individual 5.6 m high with a stem diameter of 13.3 cm at 20 cm above ground.

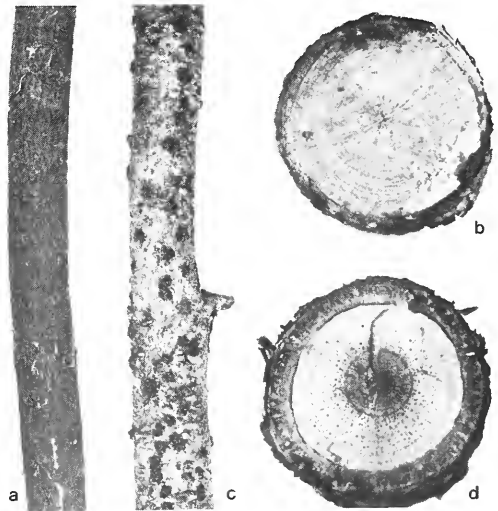


FIG. 2.—Exterior view and cross-section of (a, b) the darker striated type and (c, d) the light coloured lenticellular type of *Burkea africana* root.

Thumb nail scratch colour has the same range. Bark not hard or particularly soft, not fleshy, thickness commonly between 10 and 25% of root diameter. Samples from 15 trees gave a mean bark thickness as a percentage of root diameter as 15.1 with a standard deviation of 2.3. Bark peels relatively easily but strips in long lengths usually only on thin roots, bark of medium-tensile strength. **Wood:** Creamy white to yellow. Pith usually coloured differently to rest of

wood, pith colour varies from very light salmon pink through to purple pink which may spread over much of the wood section. Wood hard. Rings usually evident, rays not readily visible. Wood at cambium layer generally smooth or with small striations. *General*: Root system with lateral branching at base; roots usually fairly straight.

Because the appearance of *Burkea africana* roots may vary considerably, they are sometimes difficult to identify. Inner bark and wood colouration is usually distinctive, but may be confused with that of *Ximenia caffra*, and the two *Lannea* species, but it has a significantly ($P=0.001$) lower relative bark thickness than that of these three species and it has a usually drier inner bark than that of these species.

2. *Combretum molle* R. Br. ex G. Don (Figs 3 & 4)

Outer bark: Variable blotches of brown and dark blackish brown, golden brown and cream; irregular protrusions sometimes present; golden brown single layer papery flakes sometimes present. *Inner bark*: No inner bark apparent; thumbnail scratch colour shows the yellow wood; bark peels very difficultly and does not strip in long lengths, bark thickness com-

monly not more than 5% of root diameter. *Wood*: Yellow pith colour often slightly darker than that of wood; hard; rings with pores sometimes clear, rays not clearly visible; wood at cambium layer generally smooth. *General*: Root system extensively and laterally branched at base; roots usually fairly straight.

Extremely thin bark with a lack of protrusions arranged in whorls characterizes this species.

3. *Combretum zeyheri* Sond. (Figs 5 & 6)

Outer bark: Varying proportions of cream and brown blotches; usually smooth with few or no protrusions; usually has powdery fine scales that may be rubbed off slightly. *Inner bark*: Orange; thumbnail scratch colour very bright orange; not hard, medium fleshy; bark thickness commonly between 20 and 35% of root diameter; bark removable but not stripping in long lengths; low tensile strength. *Wood*: Yellowish to orangish; pith colour sometimes reddish; wood fairly close-grained; pores usually visible; ring-structures usually evident, rays not; wood at cambium layer with imperfectly parallel striations. *General*: Root system with branching near base; roots usually fairly straight.

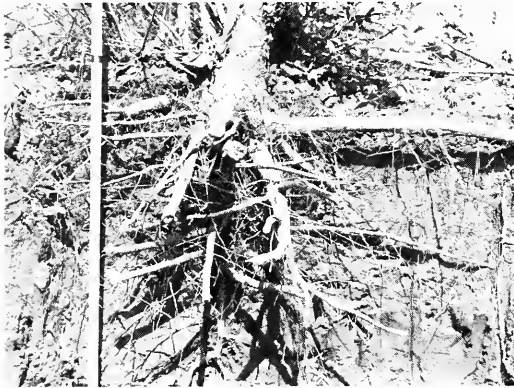


FIG. 3.—Root system of a two-stemmed individual of *Combretum molle* 5.7 m high with stem diameters of 12.2 cm and 12.5 cm at 20 cm above ground.

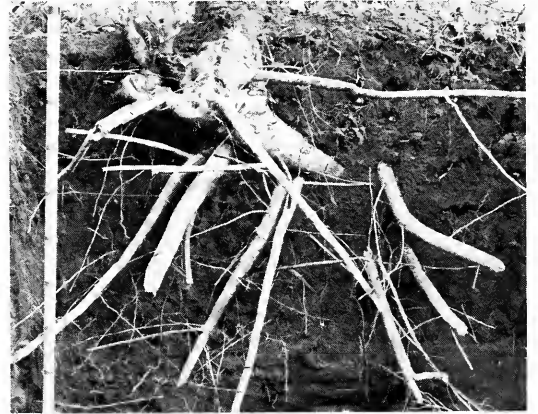


FIG. 5.—Root system of a *Combretum zeyheri* individual 6.3 m high with a stem diameter of 15.8 cm at 20 cm above ground.

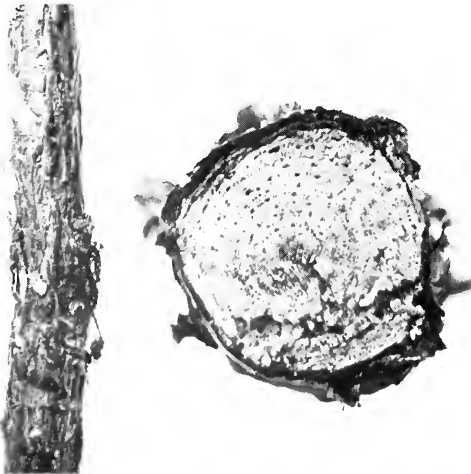


FIG. 4.—Exterior view and cross-section of a *Combretum molle* root.

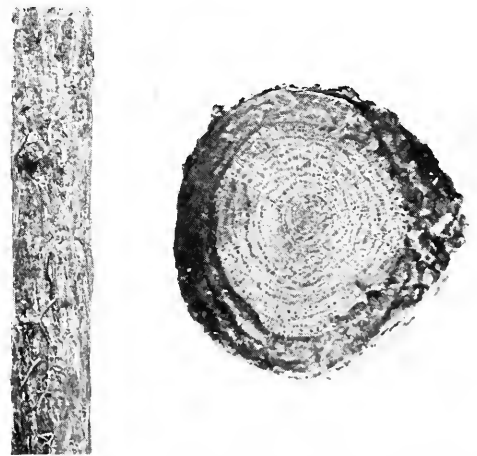


FIG. 6.—Exterior view and cross-section of a *Combretum zeyheri* root.

The bright orange colour that appears with the thumbnail scratch mark is unmistakable and clearly distinguishes this from the other species.

4. *Dichapetalum cymosum* (Hook.) Engl. (Figs 7 & 8)

Outer bark: Creamy yellow, protrusions sometimes present; fairly smooth with some evenly coloured reticulation pattern sometimes present.

Inner bark: White to light yellow; thumbnail scratch colour usually white; bark not hard nor particularly soft; not fleshy; thickness commonly between 10 and 20% of root diameter; bark peels relatively easily, but usually only strips in short lengths; bark of low tensile strength. **Wood:** Light and dark yellow; wood not hard; cross-section shows regular alternation of dark yellow and light yellow wedges; wood at cambium layer has striations that change in width. **General:** Root system with shallow lateral connections between individuals; roots usually less than 1 cm in diameter and fairly straight.

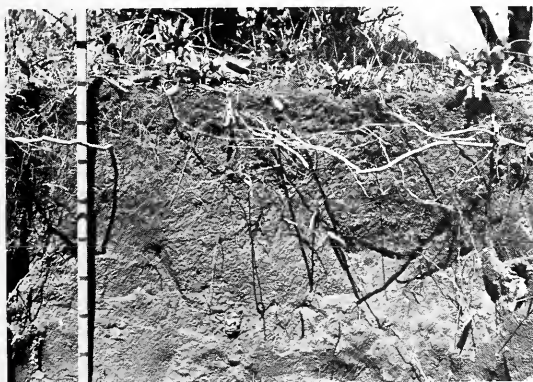


FIG. 7.—Root systems of interconnected individuals of *Dichapetalum cymosum*.



FIG. 8.—Exterior view and cross-section of a *Dichapetalum cymosum* root.

Wood cross-section with its very characteristic alternation of light yellow and dark yellow wedges and the non-corky outer bark characterize *D. cymosum*.

5. *Dichrostachys cinerea* (L.) Wight & Arn. (Figs 9 & 10)

Outer bark: Cream; no protrusions; very loose flakes layered on top of one another forming irregular stacks; outer bark usually as thick as inner bark. **Inner bark:** Greenish white; thumbnail scratch colour whitish, sometimes greenish; bark soft, not fleshy; total bark thickness in the order of 10% of the root diameter (flaking makes measurement approximate); bark peels easily, stripping in long lengths; at least medium tensile strength. **Wood:** Orangi yellow; wood close-grained; rings sometimes evident, rays not; wood at cambium layer has orange and yellow striations. **General:** Root system extensively branched at base; roots usually straight.



FIG. 9.—Root system of a two-stemmed individual of *Dichrostachys cinerea* 2.8 m high, with stem diameters of 5, 7 and 4, 7 cm at 20 cm above ground.

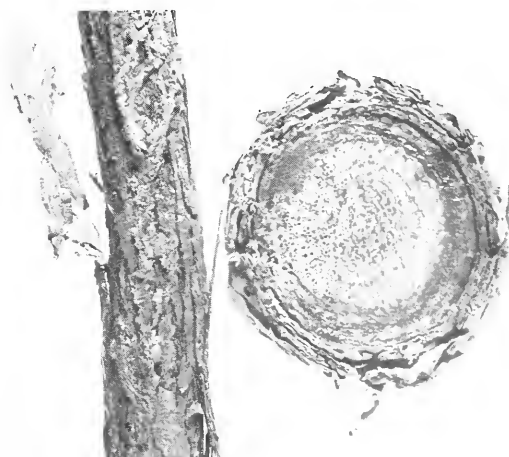


FIG. 10.—Exterior view and cross-section of a *Dichrostachys cinerea* root.

This species is clearly distinguished from *Combretum molle*, which may also have papery bark, by its cream bark colour, thicker bark and multi-layered papery bark layers.

6. *Dombeya rotundifolia* (Hochst.) Planch. (Figs 11 & 12)

Outer bark: Creamy with various usually brownish blotches; lenticellular protrusions often in short rows at right angles to the longitudinal axis of the root. *Inner bark*: Light pink (sometimes very light pink with orange spots under protrusions) in the outer area to clear, reddish or whitish in the inner area; the pink in the outer areas is often concentrated in longitudinal 'canals'; thumbnail scratch colour pale pink to very bright red; bark not hard, fairly fleshy; thickness commonly between 30 and 50% of the root diameter; bark peels relatively easily and strips in long lengths; medium tensile strength, but breakable by hand. *Wood*: Pale yellow; pith colour sometimes pink, particularly in those roots with deeper coloured bark; wood close-grained; very fine pores sometimes visible; rings sometimes clear, rays less evident; wood at cambium layer generally smooth or finely striated. *General*: Root system extensively branched at base; roots usually straight.

This species may be confused with *Ximenia caffra*, *Lannea edulis* and *Lannea discolor* and some forms of *Burkea africana* roots. However, the inner surface of the inner bark seen when the bark is partially stripped

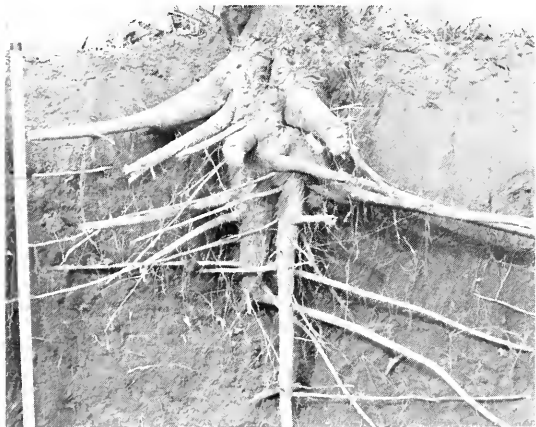


FIG. 11.—Root system of a *Dombeya rotundifolia* individual 6,2 m high with a stem diameter of 25,6 cm at 20 cm above ground.

away from the wood changes from whitish to a deep brownish yellow within three minutes of exposure. The yellow colour of the wood also deepens with exposure. This character distinguishes *Dombeya rotundifolia* from the associated species.

7. *Euclea natalensis* A. DC. (Figs 13 & 14)

Outer bark: Blackish, dark brown to very dark brown; usually no protrusions; smooth but with slight reticulate longitudinal fissures. *Inner bark*: Light yellow, becoming deep yellow within half-a-minute to one minute of exposure; thumbnail scratch colour light yellow, deeper scratch light yellow becoming dark yellow half-a-minute to one minute of exposure; orange strands visible in deeply scratched bark but within half-a-minute of exposure change together with the rest of the bark to a deep yellow colour; bark not particularly soft or hard; fairly fleshy; thickness commonly between 30 and 40% of the root diameter; bark peels relatively easily, but does not strip in long lengths; low tensile strength. *Wood*: Light yellow becoming very deep yet bright yellow within half-a-minute to one minute of exposure; pith sometimes slightly darker than rest of wood; wood close-grained; rings may be visible, but rays not obvious; wood at cambium layer has striations more clearly seen within the first half minute of

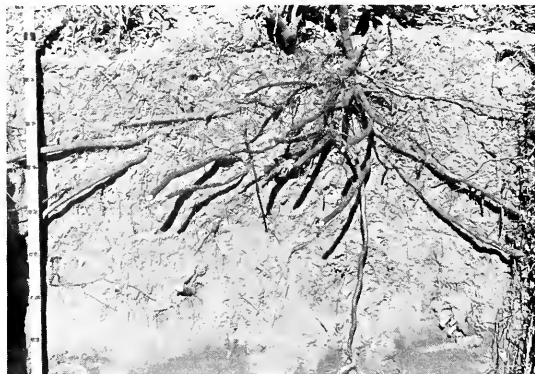


FIG. 13.—Root system of a multi-stemmed individual of *Euclea natalensis* 1,5 m high.

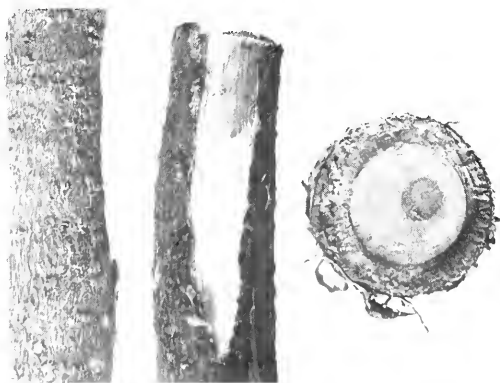


FIG. 12.—Exterior views and cross-section of a *Dombeya rotundifolia* root. A root with wood freshly exposed and exposed for 3 minutes indicates the differential colouration

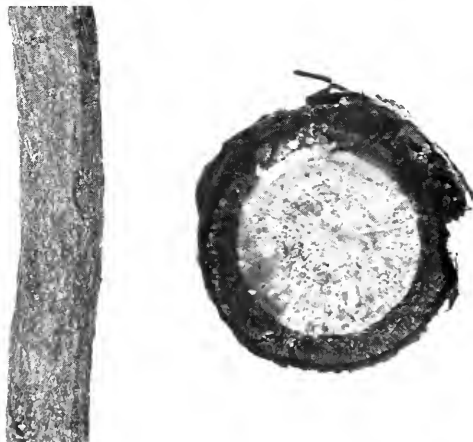


FIG. 14.—Exterior view and cross-section of a *Euclea natalensis* root.

exposure. *General*: Root system extensively branched at base; roots usually fairly straight.

Inner bark and wood colour changes from light yellow to deep yellow on exposure at a rate so rapid that one can see the colour changing; this character distinguishes *E. natalensis* from the other savanna species.

8. *Fadogia monticola* Robyns (Figs 15 & 16)

Outer bark: Light brown to brown; many regular protrusions all facing in one direction longitudinally and positioned in whorls of three; longitudinal fissures usually present. *Inner bark*: Too thin to see colour; thumbnail scratch colour shows whitish, light yellow colour of wood; bark not fleshy; thickness commonly less than 5% of root diameter; bark removes difficultly and does not strip in long lengths. *Wood*: Yellow; close-grained; rings and rays occasionally visible; wood at cambium layer usually smooth. *General*: Root system with shallow lateral connections between individuals; roots fairly straight to contorted.



FIG. 15.—Root systems of interconnected individuals of *Fadogia monticola* 0.5 m high.



FIG. 16.—Exterior view and cross-section of a *Fadogia monticola* root.

Protrusions in whorls of three characterize this species.

9. *Grewia flavescens* Juss. (Figs 17 & 18)

Outer bark: Dark brown to blackish brown; protrusions usually not obvious; reticulate pattern often present, sometimes grooved. *Inner bark*: Pinkish;

thumbnail scratch colour pale pink to white; bark not particularly soft or hard; not fleshy; very fibrous; thickness very variable and depends on position of eccentricity of radial growth; bark peels easily and strips in long lengths; high tensile strength. *Wood*: Deep yellow; wood hard and close-grained; radial growth in most cases markedly eccentric, with the pith often at the edge of the wood; the eccentric growth is also reflected in the bark; pores sometimes visible; wood cross-section with alternating lighter and darker eccentric yellow bands; usually no rays visible; wood at cambium layer fairly smooth or with light striations. *General*: Root system with much branching at base; roots usually straight.



FIG. 17.—Root system of a multi-stemmed individual of *Grewia flavescens* 1.6 m high.

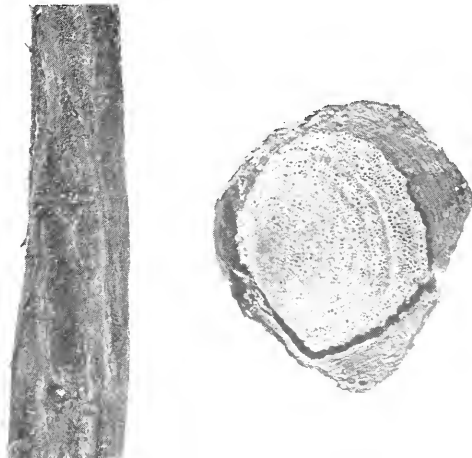


FIG. 18.—Exterior view and cross-section of a *Grewia flavescens* root.

Usually markedly eccentric radial growth together with lighter and darker alternating yellow bands in wood cross-section together with the usually dark brown outer appearance of the roots distinguishes this species from *Terminalia sericea*.

10. *Lannea discolor* (Sond.) Engl. (Figs 19 & 20)

Outer bark: Creamy blotches, though sometimes fairly evenly light brown to cream; usually at least some irregularly distributed rounded protrusions (corresponding to protrusions of the wood at the cambium layer); usually very few such protrusions on thinnest

(less than 5 mm diameter) roots; bark often flaking slightly. *Inner bark*: Reddish purple in the outer layers to pinkish, yellow, light yellow to yellowish clear in the inner layers; in very thin roots no red colour in inner bark only a uniform white colour; alternation of reddish and white longitudinal strands (occasionally with irregular large orange specks set in between) in outer layers; thumbnail scratch colour bright reddish purple, sometimes pink; bark soft; fleshy with relatively high water content; thickness commonly between 30 and 50% of root diameter; bark peels easily, although often tearing into a tapering (in thickness) strip; bark stripping in long lengths on thin roots; fairly high tensile strength. *Wood*: Yellowish white; on thicker roots purplish pink pith; close-grained; very fine pores sometimes visible in cross-section; rings sometimes visible; rays not obvious; wood at cambium layer generally smooth, but with very fine parallel striations. *General*: Root system with extensive lateral branching; roots usually fairly straight.

This species may be confused with *Dombeya rotundifolia*, *Ximenia caffra* and *Lannea edulis* as well as some forms of *Burkea africana* roots. However, it does not have the colour reaction of *Dombeya*

rotundifolia; its inner bark is thicker than that of *Burkea africana*. The bark of this species usually peels in longer lengths than that of *Ximenia caffra*. Sometimes, however, it is difficult to distinguish this species from *Lannea edulis*, although *Lannea discolor* roots typically do not have the outer bark cracking in large regular block shapes, the bark often does not peel more cleanly away from the wood, pale tan coloured lenticellular structures are seldom present, the wood at the cambium layer has slightly less pronounced pale thread-like striations and the pith is usually not softer than the rest of the wood.

11. *Lannea edulis* (Sond.) Engl. (Figs 21 & 22)

Outer bark: Creamy to dark brown; often have large rounded protrusions and pale light brown lenticels with no corresponding marks on the wood surface below the bark; bark often cracking in large square patches on thicker roots. *Inner bark*: Pale to dark pink or purple and red on the outside to white on the inside; red and white longitudinal canals in the outer layers together with large orange specks; thumbnail scratch colour pale pink through to bright red; bark soft, very fleshy, thickness commonly in the order of 25 to 40% of root diameter; bark peels relatively easily and strips in long lengths without radial taper; medium tensile strength but breakable



FIG. 19.—Root system of a *Lannea discolor* individual 6,7 m high with a stem diameter of 28,7 cm at 20 cm above ground.



FIG. 21.—Root systems of interconnected individuals of *Lannea edulis*.



FIG. 20.—Exterior view and cross-section of a *Lannea discolor* root.

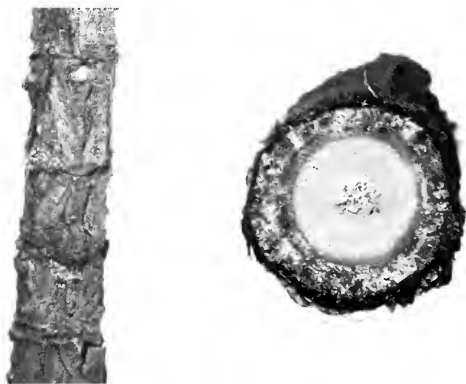


FIG. 22.—Exterior view and cross-section of a *Lannea edulis* root.

by hand. *Wood*: Pale yellow to yellow; pith usually light pink (pith colour sometimes spreading through most of the wood) and appears to be softer or more loosely packed than the rest of the wood; ring structures and rays not readily visible; pores sometimes clear in cross-section; wood at cambium layer has fine raised whitish thread-like striations. *General*: Root system with lateral connections between individuals; roots usually fairly straight.

This species may be confused with *Dombeya rotundifolia*, *Ximenia caffra* and *Lannea discolor* as well as some forms of *Burkea africana* roots. However, it does not have the colour reaction of *Dombeya rotundifolia*; its bark is thicker than that of *Burkea africana*. The bark of this species usually peels in longer lengths than that of *Ximenia caffra*. Sometimes, however, it is difficult to distinguish this species from *Lannea discolor*, although *Lannea edulis* roots typically have the outer bark cracking in large rectangular block shapes, the bark often peels more cleanly away from the wood, pale tan coloured lenticular structures are often present and the wood of the cambium layer has slightly more pronounced striations than that of *Lannea discolor*.

12. *Ochna pulchra* Hook. (Figs 23 & 24)

Outer bark: Light brown to reddish brown; no regular protrusions; sometimes large flakes present especially on thicker roots. *Inner bark*: Purple to pink; thumbnail scratch colour reddish purple; bark



FIG. 23.—Root systems of individuals of *Ochna pulchra* with mean height of 2.2 m and mean diameter at 20 cm above ground of 6.4 cm.



FIG. 24.—Exterior view and cross-section of an *Ochna pulchra* root.

hard; not fleshy; thickness commonly in the order of 25% of root diameter; bark removal possible but not readily and does not strip in long lengths; bark of low tensile strength. *Wood*: Light yellow; pith often pinkish or purplish; wood close-grained; rings usually not obvious but distinctly visible fine lines of alternating lighter and darker yellow rays; wood at cambium layer generally smooth with very fine striations. *General*: Root system very variable but usually with strong lateral development at about 30 cm depth with connections between individuals sometimes present; roots usually contorted.

Sometimes may be confused with roots of *Burkea africana*, mainly based on similar colouration, however, *Burkea africana* roots are very seldom contorted and do not have easily discernible wood rays.

13. *Ozoroa paniculosa* (Sond.) R. & A. Fernandes (Figs 25 & 26)

Outer bark: Creamy light brown; protrusions usually present in irregular pattern; smooth sometimes with a trace of reticulated fissures. *Inner bark*: Reddish; thumbnail scratch colour is pinkish orange or reddish with latex if scratch not very shallow; copious exudation of white latex from cut surfaces; bark soft, fleshy and thickness commonly in the order



FIG. 25.—Root system of a multi-stemmed individual of *Ozoroa paniculosa* 1.3 m high.

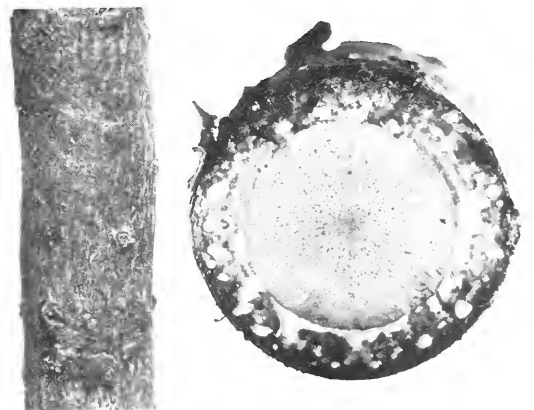


FIG. 26.—Exterior view and cross-section of an *Ozoroa paniculosa* root.

of 40% of root diameter; bark peels relatively easily but does not strip in long lengths; bark of low tensile strength. *Wood*: Light yellow; pith often pinkish; wood hard; rings and rays not always readily visible; wood at cambium layer with fine striations. *General*: Root system with lateral branching at base and roots usually straight.

The copious exudation of white latex from severed bark characterizes this species.

14. *Parinari capensis* Harv. (Figs 27 & 28)

Outer bark: Whitish grey with brown blotches; usually no protrusions; smooth with small wrinkles in places. *Inner bark*: Reddish purple; thumbnail scratch colour purple but changing to light salmon pink on thinner roots; bark neither hard nor soft and not fleshy; thickness commonly in the order of 20 to 25% of the root diameter; bark comes away relatively easily but does not strip in long lengths; bark of low tensile strength. *Wood*: Reddish near the centre to whitish on the outside; pith often reddish; wood close-grained; many evenly spread pores clearly visible in cross-section; few broad bands of rings sometimes visible; rays not readily visible; wood at cambium layer strongly striated with very clear and parallel striations (almost furrowed) and sometimes

with reddish irregular patches on the wood particularly on thicker roots. *General*: Root system with lateral connections between individuals; roots sometimes contorted.

Possibly may be confused with the whitish form of *Burkea africana* roots, however, *Burkea* does not have the same striations. Freshly excavated roots of *Parinari capensis* may then be separated from all other species on the basis of the overall colour of the outer bark being more white than cream and on having almost furrowed striations on the wood surface.

15. *Pygmaeothamnus zeyheri* (Sond.) Robyns (Figs 29 & 30)

Outer bark: Brown to dark brown; irregular rounded protrusions usually present. *Inner bark*: Yellow with orange specks; thumbnail scratch colour yellow, deeper scratches expose longitudinal non-continuous orange strands set in yellow (pale orange in thinner roots); bark neither hard nor soft and not fleshy; thickness commonly in the order of 20–25% of the root diameter; bark removable but does not strip in long lengths; low tensile strength. *Wood*: Yellow; pith sometimes purplish red and sometimes only a dark spot; wood close-grained; rings not readily visible but rays sometimes visible; wood at cambium layer has clear but often fine striations.



FIG. 27.—Root systems of interconnected individuals *Parinari capensis*.



FIG. 29.—Root systems of interconnected individuals of *Pygmaeothamnus zeyheri*.

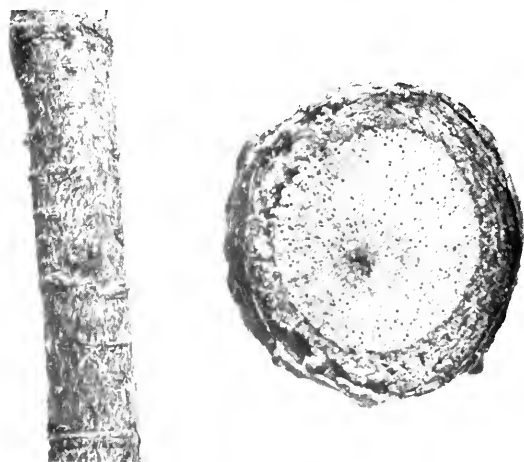


FIG. 28.—Exterior view and cross-section of a *Parinari capensis* root.



FIG. 30.—Exterior view and cross-section of a *Pygmaeothamnus zeyheri* root.

General: Root system with shallow lateral connections between individuals; roots sometimes contorted.

May be confused with *Lannea discolor*, *Lannea edulis*, *Ximenia caffra* or *Dombeya rotundifolia*. However, all these species have orange specks set in or positioned near reddish-pinkish tissue in the bark and the shape of the orange specks are often more round than those in *Pygmaeothamnus zeyheri* where they form longer strands set in yellowish (not reddish) tissue.

16. *Securidaca longipedunculata* Fresen. (Figs 31 & 32)

Outer bark: Uniform light to deep yellow colour; protrusions very seldom present; smooth but sometimes with circumferential wrinkles on the thicker roots. *Inner bark*: Yellow, thumbnail scratch colour very light yellow; bark soft and fairly fleshy; thickness commonly between 50 and 70% of the root diameter; bark with very distinctive smell of menthyl salicylate (oil of wintergreen); bark peels easily and sometimes strips in long lengths; low to medium tensile strength. *Wood*: Yellow but darker than the bark; not particularly close-grained; pores visible in cross-section; rings and rays not obvious; wood at cambium layer smooth or sometimes very slightly striated. *General*: Root system mainly a tap root but with several lateral roots. Roots normally straight.

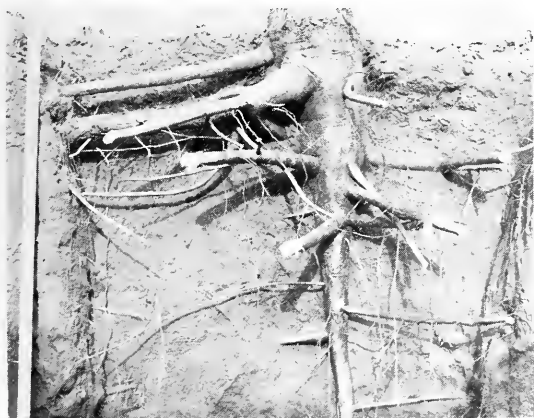


FIG. 31.—Root system of a *Securidaca longipedunculata* individual 6,1 m high with a stem diameter of 19,5 cm at 20 cm above ground.

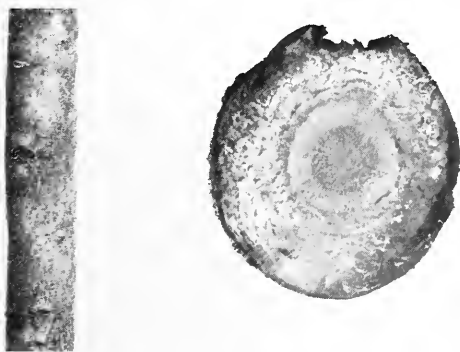


FIG. 32.—Exterior view and cross-section of a *Securidaca longipedunculata* root.

Cannot be confused with any other species, because of the distinctive smell of menthyl salicylate in the bark.

17. *Strychnos cocculoides* Bak. (Figs 33 & 34)

Outer bark: Yellowish beige; deeply furrowed corky bark. *Inner bark*: Creamy yellow; inner bark only $\frac{1}{3}$ to $\frac{1}{2}$ as thick as the outer bark; bark very soft, not fleshy; bark thickness commonly in the order of 35% of root diameter; bark does not remove easily and does not strip in long lengths; very low tensile strength. *Wood*: Creamy yellow; pith often a darker yellow than the wood; wood close-grained; ring structures clear and light yellow radial lines alternate regularly with darker yellow wedges; wood at cambium layer appears smooth. *General*: Root system with tap root and relatively little lateral branching at base; roots usually straight.

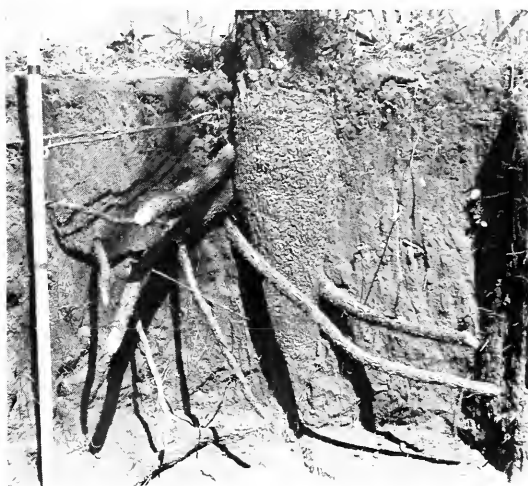


FIG. 33.—Root system of a *Strychnos cocculoides* individual 7,2 m high with a stem diameter of 30,0 cm at 20 cm above ground.

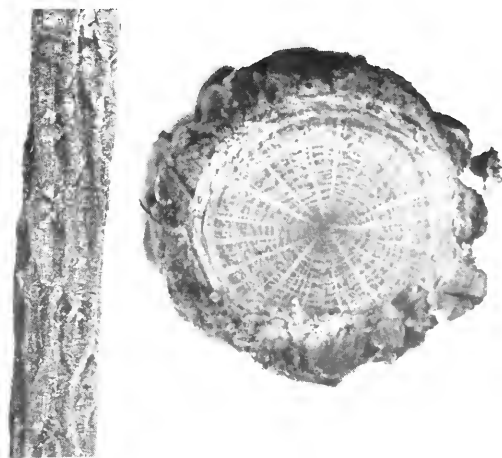


FIG. 34.—Exterior view and cross-section of a *Strychnos cocculoides* root.

May always be distinguished from other species by the extremely thick and corky outer bark.

18. *Strychnos pungens* Soler. (Figs 35 & 36)

Outer bark: Light brown; protrusions sometimes present; fairly smooth but sometimes wrinkled on thicker roots with a slightly reticulated furrow pattern on thinner roots. *Inner bark*: Yellow; bark thickness commonly in the order of 20 to 40% of root diameter; bark removable and does not strip in long lengths; low tensile strength. *Wood*: Creamy yellow to yellow; wood not close-grained and very pithy, sometimes monocotyledonous appearance in cross-section; no rings or rays readily visible; wood at cambium layer striated. *General*: Root system a tap root with relatively little lateral branching; roots straight to curved.



FIG. 35.—Root system of a *Strychnos pungens* individual 6,2 m high with a stem diameter of 28,5 cm at 20 cm above ground.

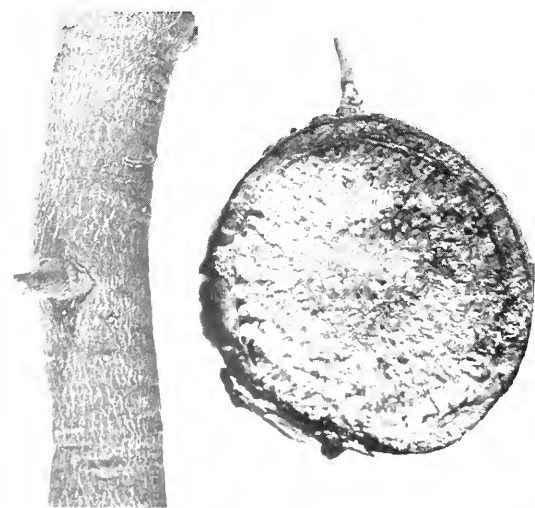


FIG. 36.—Exterior view and cross-section of *Strychnos pungens* root.

May always be distinguished from the other species by its particularly pithy wood.

19. *Terminalia sericea* Burch. ex DC. (Figs 37 & 38)

Outer bark: Cream to brown; sometimes with numerous pale lenticellular type structures; sometimes with longitudinal fissures. *Inner bark*: Yellowish but on thicker roots purple in the outer layers and yellow in the inner layers; thumbnail scratch slight pinkish to dark purplish; bark is fairly soft, not fleshy; thickness commonly between 30 and 50% of the root diameter; bark peels relatively easily and strips in long lengths; very high tensile strength. *Wood*: Yellow; pith sometimes darker shade than wood; wood hard; ring structures usually clear but rays not readily visible; wood at cambium layer smooth on thin roots but with definite striations on thicker roots. *General*: Root system with lateral branching usually also with very shallow lateral roots [also found by Cole & Brown (1976) in Botswana]; roots generally straight.



FIG. 37.—Root system of a *Terminalia sericea* individual 5,7 m high with a stem diameter of 12,9 cm at 20 cm above ground.

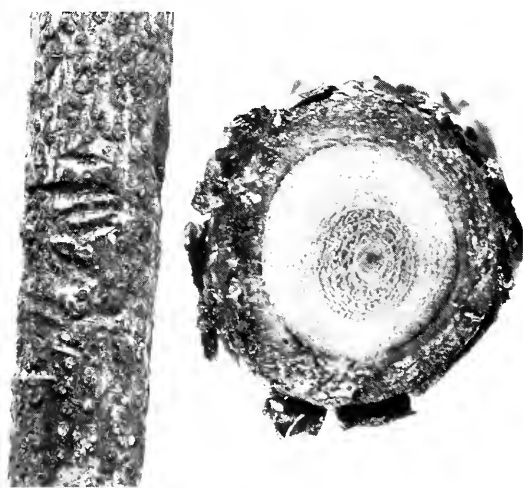


FIG. 38.—Exterior view and cross-section of a *Terminalia sericea* root.

Thinner roots may be sometimes confused with those of *Grewia flavescens*, however, the wood of *Terminalia sericea*, seen in cross-section, does not have lighter and darker yellow bands.

20. *Vitex rehmannii* Guerke (Figs 39 & 40)

Outer bark: Yellowish cream; no obvious protrusions; smooth with some small very soft flakes. **Inner bark:** Uniformly smooth when cut in cross-section; almost a translucent yellowish green, the green sometimes becoming more intense with exposure; thumbnail scratch colour is white; also often becoming greenish with exposure; soft and very fleshy; thickness commonly between 30 and 40% of the root diameter; bark separates easily but does not strip in long lengths; low tensile strength. **Wood:** Yellow; wood hard; rings and rays sometimes obvious; wood at cambium layer has fine striations. **General:** Root system extensively branching at base; roots usually fairly straight.

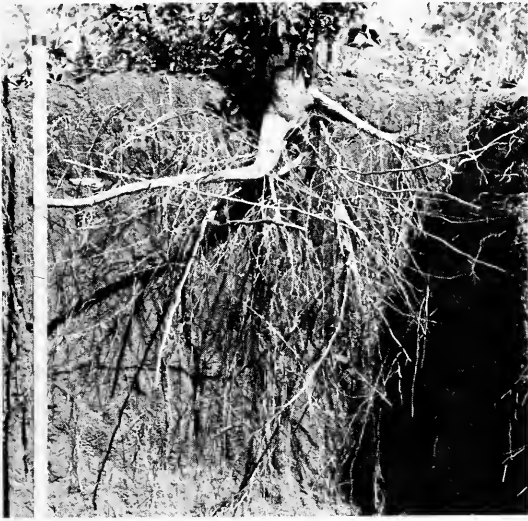


FIG. 39.—Root system of a *Vitex rehmannii* individual 5.1 m high with a stem diameter of 8.2 cm at 20 cm above ground.

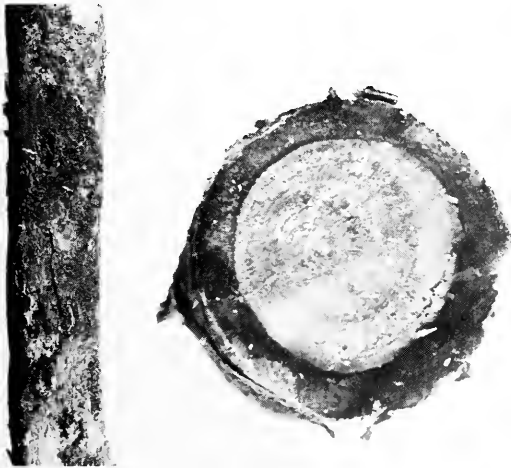


FIG. 40.—Exterior view and cross-section of a *Vitex rehmannii* root.

May always be distinguished from other species by the definite green colour contained in the fleshy inner bark. The bark is also non-flaky and has no discernible smell of menthyl salicylate.

21. *Ximenia caffra* Sond. (Figs 41 & 42)

Outer bark: Blotchy creamy to light brown; protrusions sometimes present; fairly smooth; sometimes with faint longitudinal wavy lines. **Inner bark:** Reddish purple on thicker roots to white on thinner roots with the deeper colour outside and paler towards the centre; thumbnail scratch colour white (on small roots) through pale pink to pinkish purple (usually mottled); deep scratch mark shows fine orange strands or yellow fibres set in red or pink tissue; bark soft to very soft, rubbery and fleshy; thickness commonly between 25 and 45% of the root diameter; peels relatively easily but does not strip in long lengths (breaks off in short chunks leaving yellowish orange or yellow strands emerging from those layers of the inner bark closer to the wood); low tensile strength. **Wood:** Deep yellow to yellowish brown; wood hard; rings and rays seldom obvious but rings visible on thicker roots; very many fine pores usually visible in cross-section; wood at cambium layer has clear fine parallel striations; pith sometimes darker on thicker roots. **General:** Root system with branching at base; roots usually fairly straight; fleshy root galls sometimes on roots.

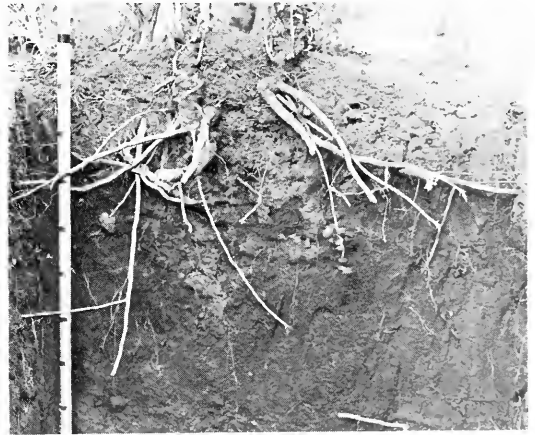


FIG. 41.—Root system of a multi-stemmed individual of *Ximenia caffra* 1.2 m high.



FIG. 42.—Exterior view and cross-section of a *Ximenia caffra* root.

The roots of this species may be confused with those of *Dombeya rotundifolia*, *Lannea discolor*, *Lannea edulis* and some forms of *Burkea africana*. However, it does not have the colour reaction of *Dombeya rotundifolia*, its bark is thicker than that of *Burkea africana* and it can be distinguished from both species of *Lannea* by having a more rubbery inner bark, that will not strip in long lengths but often breaks off in short chunks with characteristic yellow-orange or yellow strands or fibres emerging from the inner bark.

ACKNOWLEDGEMENTS

I thank Messrs P. S. Carr and M. D. Panagos for assistance in the fieldwork and Mr R. P. Ellis for suggestions on the root descriptions.

UITTREKSEL

'n Sleutel vir die uitkenning in die veld van vars wortel materiaal van 21 houtagtige plantsoorte op die

savanne ekosisteemprojek studie area, Nylsvley, Suid-Afrika, word gegee. Beskrywings van makroscopiese eienskappe van wortels asook fotografiese beskrywings van wortels en wortelstelsels word aangetoon.

REFERENCES

- COETZEE, B. J., VAN DER MEULEN, F., ZWANZIGER, S., GONSALVES, P. & WEISSER, P. J., 1976. A phytosociological classification of the Nylsvley Nature Reserve. *Bothalia* 12: 137-160.
- COLE, M. M. & BROWN, R. C., 1976. The vegetation of the Ghanzi area of western Botswana. *J. Biogeog.* 3: 169-196.
- GILBERTSON, R. L., LEAPHART, C. D. & JOHNSON, F. D., 1961. Field identification of roots of conifers in the Inland Empire. *For. Sci.* 7: 352-356.
- RUTHERFORD, M. C., 1979. Aboveground biomass subdivisions in woody species of the savanna ecosystem project study area, Nylsvley. *South African National Scientific Programmes Report* No. 36, pp 33.
- WHITE, F., 1976. The underground forests of Africa: a preliminary review. *Gardens' Bulletin* 29: 57-71.

Leaf anatomy of the South African *Danthonieae* (Poaceae).

II. *Merxmüllera disticha*

R. P. ELLIS*

ABSTRACT

The anatomical structure, of the leaf blade as seen in transverse section, and of the abaxial epidermis, of *Merxmüllera disticha* (Nees) Conert is described and illustrated. Three distinct anatomical "forms" are recognized viz. typical *M. disticha*, the Drakensberg form and the alpine bog form. These three anatomical groups also appear to have differing environmental requirements and probably warrant taxonomic status.

RÉSUMÉ

ANATOMIE FOLIAIRE DES DANTHONIEAE (POACEAE) D'AFRIQUE DU SUD. II. MERXMUELLERA DISTICHA

La structure anatomique du limbe foliaire en coupe transversale et celle de l'épiderme abaxial de *Merxmüllera disticha* (Nees) Conert sont décrites et illustrées. On reconnaît trois "formes" anatomiques distinctes, soit la forme *M. disticha* typique, la forme du Drakensberg et la forme du marécage alpin. Ces trois groupes anatomiques semblent également avoir des exigences de milieu différentes et il est probable qu'elles méritent un statut taxonomique.

INTRODUCTION

Merxmüllera disticha (Nees) Conert (1970) (= *Danthonia disticha* Nees) is probably the best known and most distinctive southern African representative of this genus. It is a wiry, tussock grass and is economically relatively important (Acocks, 1971) as it may become dominant, and completely usurp the position of better grazing grasses in certain areas. It occurs over extensive areas along the south coast and eastern mountain ranges and is an important constituent of the following veld types: *Themeda*—*Festuca* Alpine Veld, Stormberg Plateau Sweetveld and Karroid *Merxmüllera* Mountain Veld (Acocks, 1975).

This species is easily recognized by the inflorescence, which is an oblong, uninterrupted, distichous spike. It is the only species of this genus which can have 2-flowered spikelets and both the upper and lower glumes 3-nerved (Chippindal, 1955). *M. disticha* is thus distinct morphologically and only the plants with 2-flowered spikelets may be confused with *Pentaschistis basutorum* Stapf (Chippindal, 1955).

It was, therefore, most unexpected to discover that three distinct anatomical "forms" are present in this species. In addition, from the sample examined in this study, it appears that each of these three "forms" has different habitat requirements. For convenience, *M. disticha* sens. lat. has been sub-divided into three "forms" in the following descriptions and discussions: typical *M. disticha*, the Drakensberg form and the alpine bog form. Each of these forms exhibits characteristic leaf anatomy and epidermal structure.

In the anatomical descriptions which follow, the following abbreviations will be used:

- vb/s—vascular bundle/s
- 1'vb/s—first order vascular bundle/s
- 2'vb/s—second order vascular bundle/s
- 3'vb/s—third order vascular bundle/s
- ibs—inner bundle sheath; mestome sheath
- obs—outer bundle sheath; parenchyma sheath.

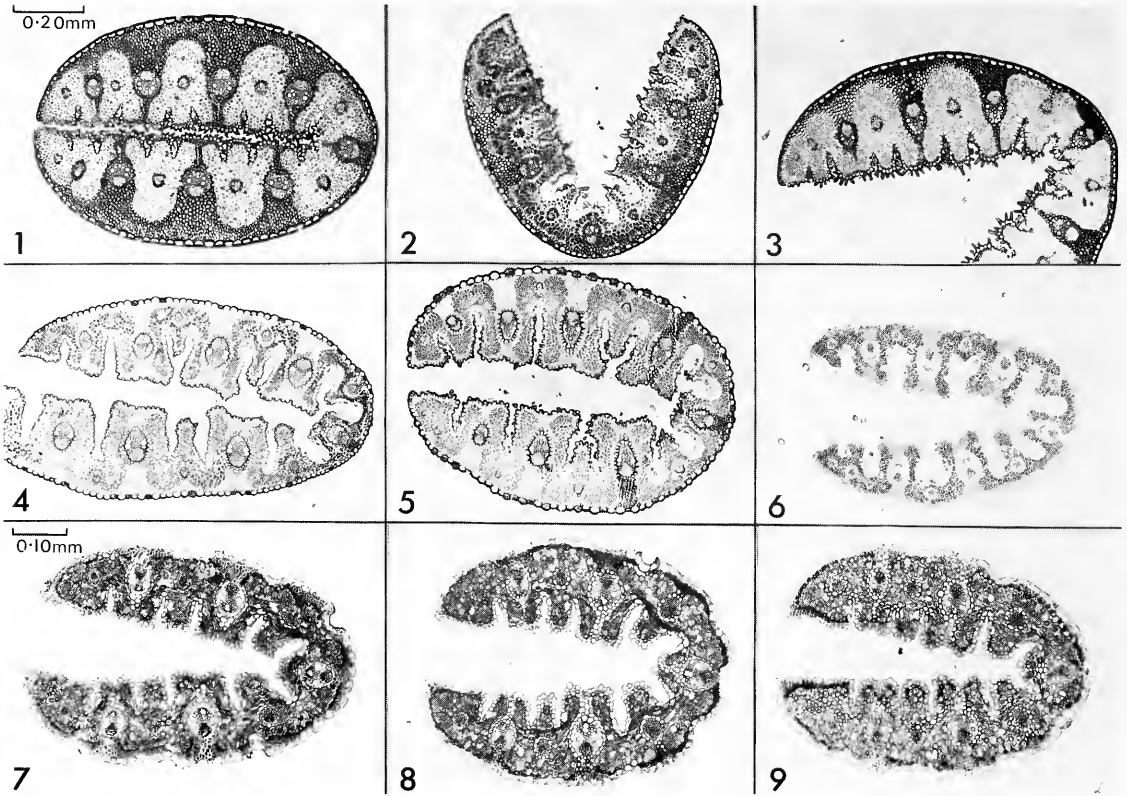
For definitions of terminology used see Ellis (1976, 1979).

ANATOMICAL DESCRIPTION OF *MERXMUELLERA DISTICHA* SENS. LAT.

Leaf in transverse section

Leaf outline: infolded with an elliptical or U-shaped outline. Symmetry about the median bundle not perfect with the 1'vbs of opposite halves of the lamina alternating. This tendency particularly marked in the Drakensberg form (Fig. 4). Leaves narrow (<1,1 mm wide) when folded. Adaxial channel normally a deep, narrow cleft. **Ribs and furrows:** adaxial furrows narrow, cleft-like and located between all vbs except the penultimate 3'vb which lies at the base of a furrow. Adaxial ribs flat-topped and angular; 1'vb ribs larger than those overlying 3'vbs. Abaxial surface without ribs or furrows. **Median vascular bundle:** present; indistinguishable structurally from other 1'vbs. **Vascular bundle arrangement:** no 2'vbs present; one 3'vb between consecutive 1'vbs; 1'vbs decrease in size towards margin. **Vascular bundle structure:** vbs circular or elliptical in shape; phloem adjoins ibs; lysigenous cavity and protoxylem vessels present; metaxylem vessels circular, extremely narrow with thickening of the walls. **Vascular bundle sheaths:** obs of 3'vbs circular or with slight abaxial interruptions in the Drakensberg form (Fig. 5); no sheath extensions. Cells rounded or elliptical, inconspicuous and much smaller than the mesophyll cells; thin walled; chloroplasts few or absent. Ibs indistinct, complete and with uniformly thickened walls. Obs of 1'vbs elliptical or horse-shoe shaped with wide adaxial and abaxial interruptions; no extensions. Sheath cells inconspicuous; smaller than both the mesophyll and the ibs cells; rounded or, more often, elliptical; thin-walled or may resemble ibs cells with u-shaped wall thickenings in typical *M. disticha* only (Fig. 1). Few or no chloroplasts present. Ibs complete; inner radial and tangential walls thickened; often adaxial ibs cells larger than lateral cells. **Sclerenchyma:** small, shallow adaxial strands associated with 3'vbs. Inversely anchor- or T-shaped adaxial girders associated with 1'vbs; width and length of girder stem variable (Table 1); girder interrupts obs. Abaxial girders not associated with 3'vbs except in Drakensberg form (Figs 4 & 5). 1'vb girders usually trapezoidal narrowing toward the bundle; fibres interrupt the obs. Continuous abaxial hypodermal sclerenchyma well

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FIGS 1-9.—Leaf blade outline of *Merxmuellera disticha* sens lat. in transverse section. 1-3, typical *M. disticha* form. All $\times 160$. (1, Ellis 2572; 2, Ellis 2564; 3, Ellis 669.) 4-6, Drakensberg form. All $\times 160$. (4, Du Toit 675; 5, Ellis 1404; 6, Ellis 3152.) 7-9, Alpine bog form. All $\times 250$. (7, Ellis 3315; 8, Ellis 3306; 9, Ellis 3316.)

developed in typical *M. stricta* (Fig. 1) but only a shallow interrupted hypodermal layer present in the alpine bog form (Figs 7-9) (Table 1). Fibres with both lignified and cellulose cell walls present in individual sections. *Margin*: relatively small, pointed, sclerenchyme cap developed. *Mesophyll*: not radiate; cells isodiametric, regular and tightly packed. Mesophyll tissue not continuous between all vbs; U-shaped chlorenchyma groups occupy sides and bases of furrows between consecutive l'vbs. No colourless cells. *Adaxial epidermis*: bulliform cells poorly developed; basal cells of furrows may be slightly enlarged to form small, fan-shaped bulliform cell groups. Epidermal cells inflated with the outer wall slightly thickened. No macro-hairs, hooks or prickles developed. Cells variously papillate; one papillus per cell. *Abaxial epidermis*: no bulliform cells present. Cuticle and epidermal cell thickening differs in the three forms. Hooks, prickles and papillae absent; macro-hair bases present in alpine bog form (Figs 7 & 8).

Abaxial epidermis

Intercostal zones: not differentiated. *Stomata*: absent throughout abaxial epidermis. *Papillae*: absent except in some specimens of the Drakensberg form where long cells are inflated and tend towards oblique papillae (Fig. 15). *Prickles*: absent. *Hooks*: none observed. *Micro-hairs*: absent except in the alpine bog form where bicellar hairs with short basal, and

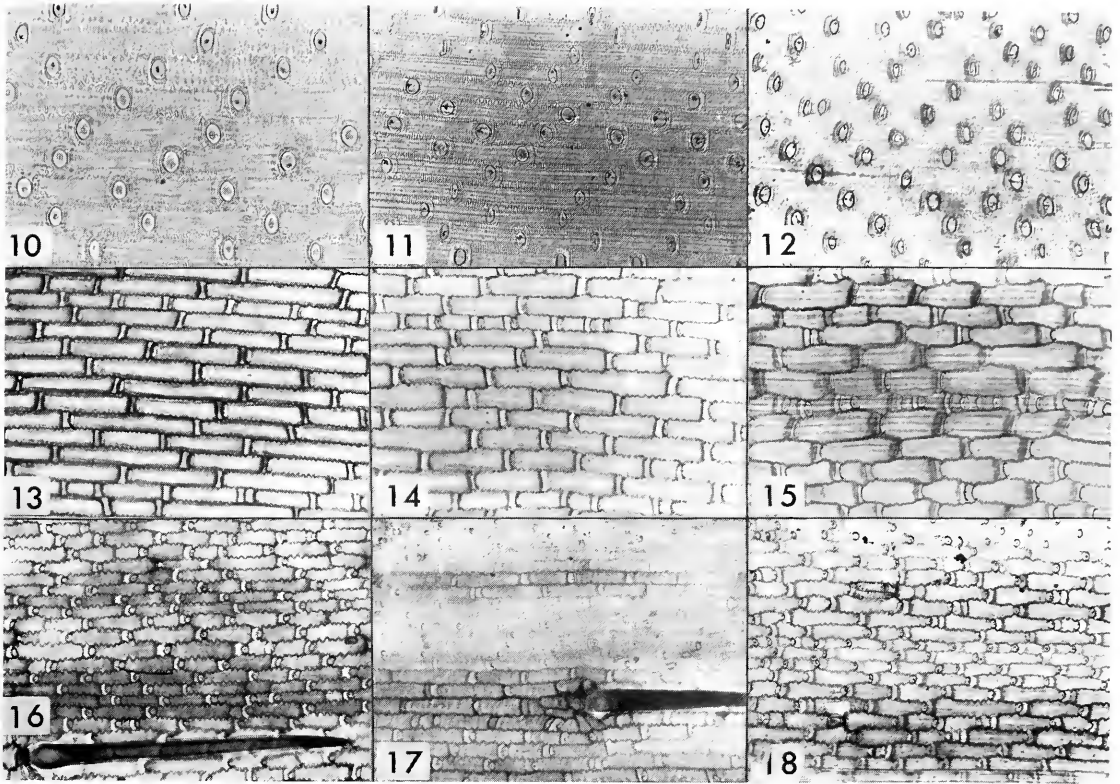
elongated, tapering distal, cells occur (Fig. 16). *Macro-hairs*: absent except on all specimens of alpine bog form (Figs 16 & 17). Uni-cellular; 2-3 specialized epidermal cells associated with hair base; base swollen in relation to hair thickness; short >1.25 mm long. *Silica bodies*: variable (Table 1); rounded in typical *M. disticha* (Figs 10-12) to tall and narrow in the Drakensberg form (Figs 13-15). Present throughout abaxial epidermis; granules present; width approximately the same as that of adjacent costal long cells especially in typical and Drakensberg forms. *Costal cells*: silico-suberose couples alternate with single costal long cell throughout abaxial epidermis; cork cells crescentic and enfolding the silica body except for tall and narrow cork cells associated with tall and narrow silica bodies in the Drakensberg form; costal long cells rectangular with straight to slightly inflated walls; slightly undulated.

Specimens examined:

Typical M. disticha

O.F.S.—2828 (Bethlehem): Golden Gate National Park, Brandwag Peak (—DA), Ellis 2391.

CAPE.—3124 (Hanover): Lootsberg (—DC), Theron 486. 3126 (Queenstown): Jamestown (—BB), Ellis 2603. 3225 (Somerset East): Groot Riet Vlei (—AD), Acocks 11961. 3226 (Fort Beaufort): 40 km from Tarkastad on Adelaide road (—AD), Ellis 2572. 3325 (Port Elizabeth): Addo Elephant National Park (—BC), Liebenberg 6656, 7713; King Neptune Beach (—DC), Ellis 2564. 3420 (Bredasdorp): between Swellendam and Riviersonderend (—AA), Ellis 1263; Potberg (—AD), Ellis 669; Cape Agulhas (—CC), Loxton 246.



FIGS 10-18.—Abaxial epidermis of *Merxmüllera disticha* sens. lat. All $\times 400$. 10-12, *M. disticha* form. (10, Liebenberg 7713; 11, Ellis 1263; 12, Ellis 669.) 13-15, Drakensberg form. (13, Ellis 3157; 14, Ellis 3152; 15, Ellis 1404.) 16-18, Alpine bog form. (16, Ellis 3183; 17, Ellis 3192; 18, Ellis 3313.)

TABLE 1.—The anatomical differences between the different forms of *Merxmüllera disticha* as seen in transverse sections of the leaf blade and on epidermal preparations in surface view

Character	Typical Form	Drakensberg Form	Alpine bog Form
1. Number of 1'vbs in leaf section	1. 7 (sometimes 5)	1. 7 (sometimes 5)	1. 5 vbs
2. Outline of lamina	2. Permanently infolded but opening of 45° possible	2. Infolded but regular opening of 180° occurs	2. Permanently infolded
3. Depth of adaxial furrows	3a. Medium $< \frac{1}{2}$ leaf thickness 3b. All furrows of equal depth	3a. Deep $> \frac{1}{2}$ leaf thickness 3b. Furrows on either side of midribs deeper than rest	3a. Medium $< \frac{1}{2}$ leaf thickness 3b. All furrows of equal depth
4. Vertical position of vascular bundles in blade	4. All bundles centrally located	4. 1'vbs centrally and 3'vbs abaxially positioned	4. All bundles centrally located
5. Adaxial sclerenchyma girders—inversely T-shaped	5. T with long, narrow stem (1-3 seriate)	5. T with short, sturdy stem (> 3 seriate)	5. T with variable stem
6. Abaxial sclerenchyma	6. Continuous hypodermal layer with girders to 1'vbs only	6. Well developed tall or trapezoidal girders associated with both 3' and 1'vbs. Hypodermal layer sometimes developed	6. Thin hypodermal layer with trapezoidal girders associated with 1'vbs only
7. Bulliform cells	7. Poorly developed at base of furrows	7. Well developed on two furrows on either side of the median bundle	7. Absent
8. Adaxial papillae	8. Long, broad, hair-like distally thickened papillae on most epidermal cells	8. Outer walls of epidermal cells inflated with a few elongated, thickened papillae present	8. Outer walls of all epidermal cells inflated
9. Abaxial epidermal cells	9. Outer tangential wall flattened with smooth, continuous cuticle	9. Outer wall inflated and projecting; not conspicuously thickened	9. Outer walls irregular but with a markedly thickened cuticle
10. Abaxial micro-hairs	10. Absent	10. Absent	10. Present
11. Macro-hairs	11. Absent	11. Absent	11. Present
12. Silica bodies	12. Rounded or circular to elliptical in shape. Equidimensional to vertically elongated	12. Tall and narrow with smooth outlines to crescentic or kidney shaped. Vertically elongated	12. Crescent or kidney shaped to cuboid or rounded. Equidimensional
13. Cork cells	13. Crescentic, enfolding silica body	13. Tall and narrow adjacent to silica body	13. Crescentic, enfolding silica body

Drakensberg form

O.F.S.—2828 (Bethlehem): Golden Gate National Park, Brandwag Peak (—DA), *Du Toit* 675. Wodehouse Peak, *Ellis* 2382; Witsieshoek—Mont-aux-Sources area (—DB), *Ellis* 3133, 3152, 3157.

NATAL.—2829 (Harrismith): Cathedral Peak, Organ Pipes Pass (—CC), *Ellis* 1404, 3185, 3303, 3305. 2929 (Underberg): Giants Castle Game Reserve (—AD), *McAllister* 112; Bannermans Pass, *Ellis* 3312.

LESOTHO.—2929 (Underberg): Mokhotlong (—AC), *Coetzee* 834.

Alpine bog form

NATAL.—2829 (Harrismith): Cathedral Peak, Organ Pipes Pass summit (—CC), *Ellis* 3183, 3184, 3192, 3306, 3309. 2929 (Underberg): Giants Castle, summit of Bannermans Pass (—AD), *Ellis* 3313, 3315, 3316; top of Sani Pass (—CB), *Du Toit* 699.

LESOTHO.—2929 (Underberg): above Sani Pass (—CA), *Du Toit* 2207.

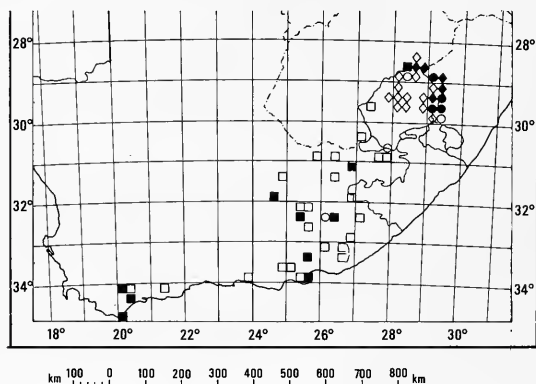


FIG. 19.—Distribution of *Merxmuellera disticha* in South Africa. □—typical *M. disticha* form; ◇—Drakensberg form; ○—Alpine bog form. Shaded symbols represent localities of specimens studied anatomically. Compiled from specimens at the National Herbarium, Pretoria (PRE).

DISCUSSION AND CONCLUSIONS

From the foregoing anatomical description of *M. disticha* sens. lat., and from the accompanying photomicrographs (Figs 1–18), it is evident that numerous anatomical differences exist between the three different forms of *M. disticha* recognized in this study (Table 1). These differences are of considerable magnitude and are much more obvious than are the anatomical differences among some of the other closely related *Merxmuellera* species e.g. *M. macowanii* (Stapf) Conert, *M. davyi* (C. E. Hubb.) Conert and *M. aureocephala* (J. G. Anders.) Conert or *M. drakensbergensis* (Schweick.) Conert and *M. stereophylla* (J. G. Anders.) Conert. In addition, the anatomical differences between *M. drakensbergensis* and *M. stereophylla*, for example, are merely a matter of degree and there is a tendency for the characters to grade from one species into the other. The differences among the three *M. disticha* forms, on the other hand, are distinctly disjunct with the characters being structurally different e.g. adaxial ribs, sclerenchyma girders, silica bodies etc. Furthermore, a number of correlated characters, from both the leaf blade in section and the epidermis, characterize each of the three forms. These diagnostic characters constantly occur in combination and with the detection of any single diagnostic character the remainder can safely be inferred. This evidence, based solely on leaf anatomical criteria suggests, therefore, that each of the forms of *M. disticha*, recognized in this study, warrants taxonomic status, possibly sub-specific rank.

In certain spikelet characters, differences are also exhibited among these three forms of *M. disticha*. From the sample examined, it appears that, in both the Drakensberg and alpine bog forms, only 2-flowered spikelets are found. In typical *M. disticha*, all specimens had three or more florets. In typical *M. disticha* and in the Drakensberg form the length of the upper and lower glumes is greater than 12 mm whereas, in the alpine bog form they are 11 mm or less in length. In both typical *M. disticha* and the Drakensberg form the lower glume was always distinctly 3-nerved, whereas in the alpine bog sample only a single prominent nerve was present with two poorly developed lateral nerves sometimes being evident. From the small sample examined, it would appear, that a detailed study of the spikelet morphology of *M. disticha* sens. lat. should confirm the anatomical groupings and assist in reaching a taxonomic decision.

The three forms of *M. disticha* show distinct vegetative differences as well, and can be readily recognised in the field. The alpine bog form has very narrow, short, setaceous leaves between 100–200 mm long and forms fine, delicate, compact but low tussocks. The younger green leaves are normally more or less straight and erect and the older, dry leaves curl, thus forming an irregularly matted “cushion” out of which the needle-like green leaves project. Typical *M. disticha* plants have a similar structure, except on a much larger scale with the leaves being from 300–500 mm long. The setaceous leaves are thicker and much more rigid and fibrous, with a very high tensile strength. The old, dry leaves of the tussock form a dense curly mass. The Drakensberg form, on the other hand, has leaves which are often not setaceous, but are open and up to 3.5 mm wide. This is especially conspicuous under conditions of reduced radiation such as on misty, cloudy days. In this state, the Drakensberg form is unmistakable and it is regrettable that in the preparation of herbarium vouchers the leaves become infolded and setaceous and the herbarium specimens resemble typical *M. disticha*. However, the green leaves are softer, more flexible and more easily torn and the old leaf blades are exceptionally curly.

Differences in habitat requirements between the three forms became evident while collecting material in the field for the anatomical investigation. Thus, the alpine bog and Drakensberg forms occur in the Drakensberg mountains but only in basaltic soils above the cave sandstone layers. On the summit of this escarpment they often occur in close proximity to one another. The alpine bog form is restricted to saturated, humic soils in shallow bogs or seepage areas and is often found in water about 100 mm deep. The Drakensberg form may be found on raised mounds in the selfsame seepage areas but obviously requires better drainage conditions. It is also more widespread being found down to altitudes of about 2 000 m, whereas the bog form is restricted to the summit at over 3 500 m.

Typical *M. disticha* has a wide distribution in the Cape Province (Fig. 19) being found at low altitudes along the southern coast and then throughout the eastern and north-eastern Cape mountains. Inexplicably it appears to be absent from the Transkei and Natal, but is found in Lesotho and the sandstone mountains of the eastern Orange Free State. Thus at Golden Gate typical *M. disticha* occurs on the slopes of Brandwag Peak (*Ellis* 2931), but higher up the same mountain, on the basalt cap known as Wode-

house Peak, the Drakensberg form is found in black, peaty soils (Ellis 2382; Du Toit 675).

The type of intraspecific variation described here, has also been observed in *M. stricta* (Schr.) Conert in similar habitats in the same mountains (Ellis, in prep.). Possibly the other closely related *Merxmuellera* species of the summer rainfall areas also represent the outcome of similar diversification and speciation e.g. *M. drakensbergensis* and *M. stereophylla* or *M. macowanii* and *M. aureocephala*. Within this genus, therefore, there appears to have been considerable adaptive radiation associated with altering environmental conditions. This applies particularly to altitude effects along this mountain range. These factors must be borne in mind when final taxonomic decisions are taken.

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UITTREKSEL

Die anatomiese struktuur van die blaar in dwarsnee en die abaksiale epidermis van Merxmuellera disticha word beskryf en geïllustreer. Drie afsonderlike anatomiese "vorme" word erken: tipiese M. disticha, die Drakensberg vorm en die alpienevlei vorm. Dit blyk ook dat hierdie drie anatomiese groepe ook verskillende omgewingsbenodigdhede het en waarskynlik taksonomiese status verdien.

REFERENCES

- ACOCKS, J. P. H., 1971. The distribution of certain ecologically important grasses in South Africa. *Mitt. bot. StSamml., Münch.* 10: 149-160.
- ACOCKS, J. P. H., 1975. Veld types of South Africa, 2nd ed. *Mem. bot. Surv. S. Afr.* 40: 1-27.
- CHIPPINDALL, L. K. A., 1955. In D. A. Meredith, *The grasses and pastures of South Africa*. Johannesburg: CNA.
- CONERT, H. J., 1970. *Merxmuellera*, eine neue Gattung der Gramineen. *Senckenberg Biol.* 51: 129-133.
- ELLIS, R. P., 1976. A procedure for standardizing comparative leaf anatomy in the Poaceae. I. The leaf blade as viewed in transverse section. *Bothalia* 12: 65-109.
- ELLIS, R. P., 1979. A procedure for standardizing comparative leaf anatomy in the Poaceae. II. The epidermis as seen in surface view. *Bothalia* 12: 641-672.

Leaf anatomy of the South African Danthonieae (Poaceae).

III. *Merxmuellera stricta*

R. P. ELLIS*

ABSTRACT

The anatomical structure, of the leaf blade as seen in transverse section, and of the abaxial epidermis, of *Merxmuellera stricta* (Schrad.) Conert is described and illustrated. In this variable species four distinct anatomical "forms" are recognized viz. the typical *M. stricta* form, the Cathedral Peak form, the Drakensberg form and the alpine form. The alpine and Cathedral Peak forms have recently been described as *M. guillarmodiae* Conert (1975). The degree of anatomical differentiation of these "forms" resembles the situation described in *M. disticha* (Nees) Conert (Ellis, 1980). Populations of both *M. stricta* and *M. disticha* from the Drakensberg mountains display extensive anatomical diversification which appears to be correlated with environmental factors. In addition, morphological differences are exhibited as well and the anatomical "forms" of *M. stricta* probably warrant taxonomic recognition.

RÉSUMÉ

ANATOMIE FOLIAIRE DES DANTHONIEAE (POACEAE) D'AFRIQUE DU SUD. III. MERXMUELLERA STRICTA

La structure anatomique du limbe foliaire en coupe transversale et celle de l'épiderme abaxial de *Merxmuellera stricta* (Schrad.) Conert sont décrites et illustrées. Dans cette espèce variable on reconnaît quatre "formes" anatomiques distinctes, soit la forme *M. stricta* typique, la forme Cathedral Peak, la forme du Drakensberg et la forme alpine. Les formes alpine et Cathedral Peak ont récemment été décrites sous le nom de *M. guillarmodiae* Conert (1975). Le degré de différenciation anatomique de ces "formes" ressemble à la situation décrite chez *M. disticha* (Nees) Conert (Ellis, 1980). Dans les montagnes du Drakensberg des populations tant de *M. stricta* que de *M. disticha* montrent une large diversification anatomique qui est apparemment en corrélation avec des facteurs de milieu. En outre, des différences morphologiques sont également manifestes et il est probable que les "formes" anatomiques de *M. stricta* méritent d'être reconnues taxonomiquement.

INTRODUCTION

Merxmuellera stricta (Schrad.) Conert (1970) [= *Danthonia stricta* (Nees) Schrad.] is widely distributed in the southern mountainous areas of South Africa. It occurs from Namaqualand in the north-west southwards to the south-western Cape, then eastwards to the north-eastern Cape mountains from where the distribution continues in a northerly direction along the Drakensberg mountains to Lesotho and the eastern Orange Free State. Together with *M. disticha* (Nees) Conert, *M. stricta* is an important constituent of the Karroid *Merxmuellera* Mountain Veld along all the higher mountains of the False Karoo and the Central Upper Karoo (Acocks, 1975). To the west of Beaufort West, *M. stricta* replaces *M. disticha* as the dominant grass of the Mountain Renosterbosveld (Acocks, 1975). *M. stricta* is also common in the fynbos communities of the south-western Cape.

M. stricta is a variable perennial, forming coarse, wiry tufts. Chippindall (1955) states that "There is considerable variation in the plants referred to *D. stricta*, and it is possible that they comprise more than one variety". In the north-west *M. stricta* may be confused with *M. dura* (Stapf) Conert, but *M. stricta* can be recognized by the glabrous condition of the lemma at the point of insertion of the central awn and is distinct anatomically (Ellis, in prep.). In the north-east, in the Drakensberg mountains, a situation exists, similar to that observed in *M. disticha* (Ellis, 1980), with three additional anatomical "forms" being present.

These anatomical "forms" appear to be correlated with morphological characters and habitat differences. Certain of the spikelet differences and other morphological characters must be of considerable magnitude

as Conert (1975) has independently described a new species, *M. guillarmodiae* Conert, from *M. stricta* collections from the alpine region of the Drakensberg.

Unfortunately, the specimens cited by Conert (1975) as belonging to *M. guillarmodiae* fall into two of the anatomical categories recognized in the present study, while the remaining two "forms" fall in *M. stricta* as currently constituted. If the precedent created by the description of *M. guillarmodiae* is to be followed, it implies that a further two species require description. Similarly, by the same token, two new species, presently referred to *M. disticha*, also warrant description (Ellis, 1980).

In the present context *M. stricta* is viewed in its widest sense, and for convenience *M. stricta* sens. lat. has merely been sub-divided into four "forms" for descriptive purposes: the typical form (*M. stricta*), the Cathedral Peak form (*M. guillarmodiae*), the Drakensberg form (*M. stricta*) and the alpine form (*M. guillarmodiae*). Each of these "forms" exhibits characteristic leaf anatomy and epidermal structure which will be described and discussed according to the terminology of Ellis (1976; 1979).

In the anatomical descriptions which follow, the following abbreviations will be used:

- vb/s—vascular bundle/s
- 1'vb/s—first order vascular bundle/s
- 2'vb/s—second order vascular bundle/s
- 3'vb/s—third order vascular bundle/s
- ibs—inner bundle sheath; mestome sheath
- obs—other bundle sheath; parenchyma sheath.

ANATOMICAL DESCRIPTION OF MERXMUELLERA STRICTA SENS. LAT.

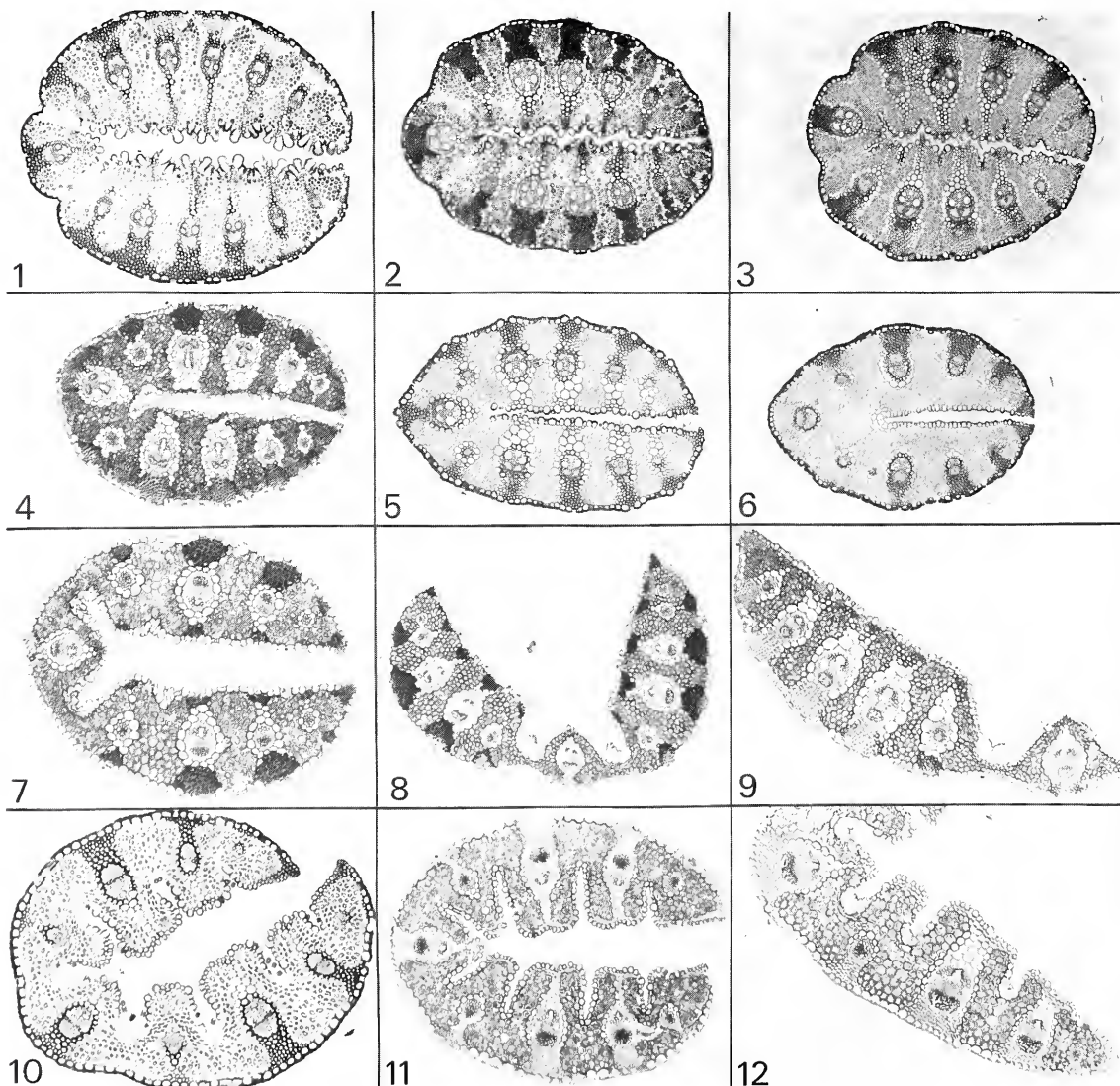
Leaf in transverse section

Leaf outline: infolded with an elliptical or U-shaped outline. Permanently infolded in typical and Cathedral Peak forms (Figs 1-6) but regular opening to 180°

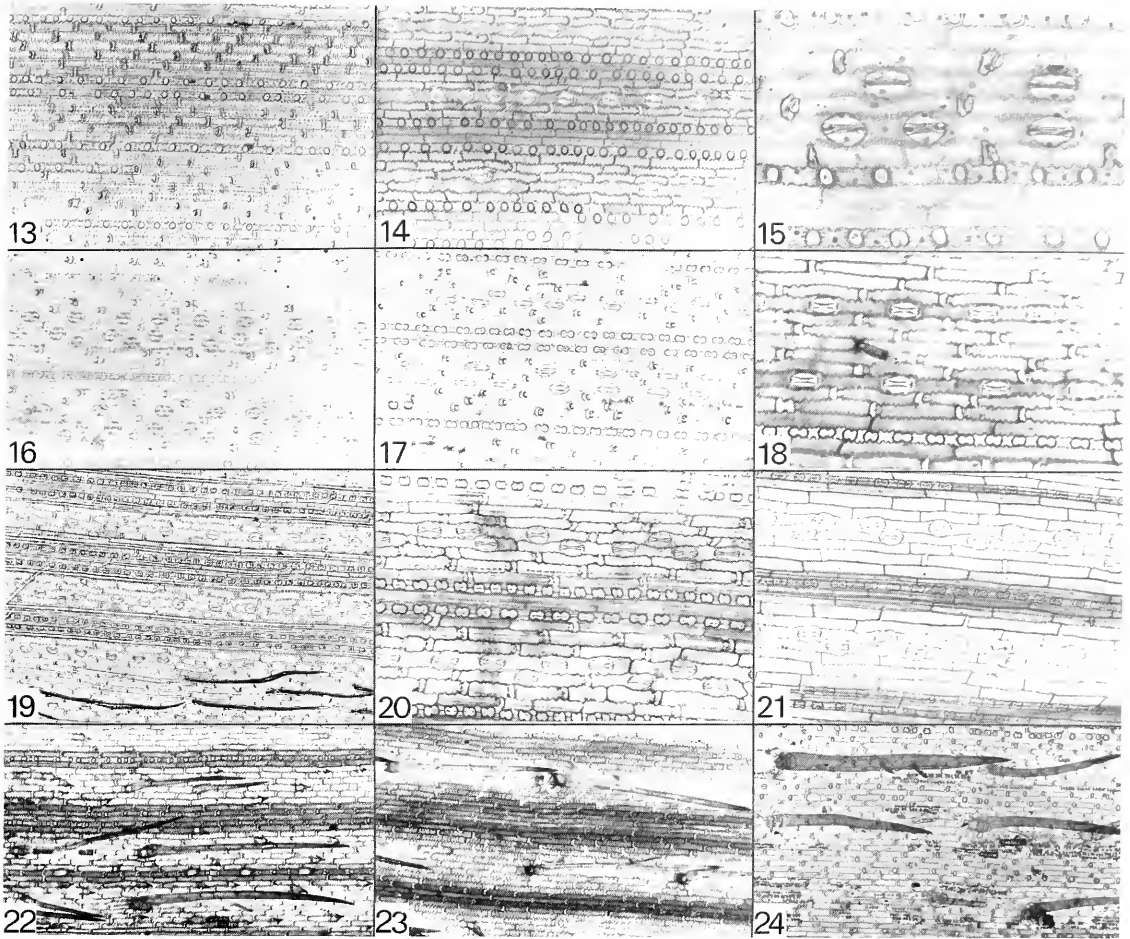
* Botanical Research Institute, Department of Agricultural Technical Services, Private Bag X101, Pretoria, 0001.

occurs in Drakensberg form (Fig. 9) and to 45° in the alpine form (Fig. 12). Lamina symmetrical about the median vb. 9–13 vbs present in leaf section (Table 1) with the alpine form always with 9 vbs (Figs 10–12) and typical *M. stricta* with 11 or 13 (Figs 1–3). Adaxial channel an extremely narrow and deep cleft in the typical and Cathedral Peak forms and is narrower than the lamina thickness in the Drakensberg and alpine forms when infolded. Leaves narrow (<1.1 mm wide) when folded. *Ribs and furrows*: adaxial furrows of variable depth but constant for each of the “forms” (Table 1); narrow, cleft-like. Similar ribs over all vbs when present; rounded or flat-topped with one vb per rib. Abaxial surface smooth except in typical *M. stricta* where grooves are present on either side of the median vb (Figs 1–3). *Median vascular bundle*: present; indistinguishable

structurally from lateral l'vbs. *Vascular bundle arrangement*: no 2'vbs; 3'vbs absent between lateral l'vbs. 3 or 4 l'vbs in each half of the lamina in typical form but decreasing to two in alpine form. All bundles located in centre of blade. *Vascular bundle structure*: vbs circular or elliptical in shape; xylem and phloem distinguishable in all vbs; phloem adjoins ms; often divided by intrusion of fibres in typical *M. stricta* (Figs 2 & 3) and the Cathedral Peak form (Fig. 5). Lysigenous cavities present. Metaxylem vessels thickened, circular and very narrow. *Vascular bundle sheaths*: obs circular or elliptical but normally horseshoe shaped due to wide abaxial interruptions. Adaxial extensions present but cell composition differs in each of the “forms”. Obs cell shape variable from round to elliptical but all cells in a given leaf similar in shape. Obs cells conspicuous but not larger than the



FIGS 1–12.—Leaf blade outline of *Merxmuellera stricta* sens. lat. as viewed in transverse section. 1–3, typical *M. stricta* form, all $\times 160$. Note abaxial grooves on either side of median bundle only. (1, Ellis 2476; 2, Ellis 2445; 3, Ellis 2441.) 4–6, Cathedral Peak form, all $\times 160$. Adaxial groove, but no furrows present. (4, Ellis 3295; 5, Ellis 2372; 6, Trauseld 833.) 7–9, Drakensberg form. Very deep adaxial furrow on either side of median vascular bundle. Leaf not permanently infolded. (7, Ellis 3318, $\times 250$; 8, Ellis 3322, $\times 160$; 9, Ellis 3321, $\times 250$.) 10–12, alpine form, all $\times 250$. Furrows developed between all vascular bundles. (10, Ellis 3181; 11, Ellis 3317; 12, Ellis 3308.)



Figs 13-24.—Abaxial epidermis of *Merxmüllera stricta* sens. lat. as seen in surface view. 13-15, typical *M. stricta* form. All with round silica bodies. (13, Roberts 2034, $\times 250$, note absence of intercostal zones; 14, Ellis 1156, $\times 250$, note stomatal files and intercostal zones; 15, Ellis 2317, $\times 640$.) 16-18, Cathedral Peak form. Silica bodies dumb-bell shaped. (16, Ellis 2372, $\times 250$; 17, Galpin 10357, $\times 250$; 18, Ellis 3289, $\times 400$.) 19-21, Drakensberg form. Dumb-bell shaped silica bodies. (19, Acocks 22069, $\times 160$; 20, Ellis 1428, $\times 400$; 21, Ellis 3290, $\times 400$.) 22-24, Alpine bog form. Silica bodies crescent-shaped, round or irregularly dumb-bell shaped. Macro-hairs, micro-hairs and prickles common. All $\times 160$. (22, Du Toit 2206; 23, Ellis 3181; 24, Ellis 1393.)

mesophyll cells; without chloroplasts (Fig. 26). Ibs complete; small cells with U-shaped thickenings; adaxial cells larger than lateral cells (Fig. 26). *Sclerenchyma*: Adaxial sclerenchyma variable from minute strands in the Cathedral Peak form (Figs 4-6) to well-developed, inversely anchor-shaped girders in typical *M. stricta* (Figs 1-3) or the alpine form (Figs 10-12) (Table 1). Abaxial girders well developed; either trapezoidal (Fig. 1 & 7) or narrower than the vb (Figs 2 & 5). In certain specimens of typical *M. stricta* individual girders fuse forming a continuous, abaxial, hypodermal band (Fig. 1). *Margin*: small, triangular, sclerenchyma caps developed. *Mesophyll*: not radiate; composed of regular, small, isodiametric, tightly packed cells (Fig. 26). Tall, narrow groups of chlorenchyma tissue between consecutive vbs separated by sclerenchyma girders. No colourless cells. *Adaxial epidermis*: bulliform cells poorly developed; basal cells of furrows may be slightly enlarged to form small, fan-shaped groups (Table 1). Epidermal cells inflated with outer wall slightly thickened. Macro-hairs and prickles absent; hooks occur irregularly.

Cells variously papillate; one papillus per cell. Adaxial papillae best developed in typical *M. stricta* (Fig. 1). *Abaxial epidermis*: no bulliform cells developed. Hooks, prickles, macro-hairs and papillae lacking. Outer tangential wall flattened with smooth, continuous cuticle.

Abaxial epidermis in surface view

Intercostal zones: differentiated except in typical *M. stricta* specimens with continuous hypodermal sclerenchyma layer (Figs 1 & 13). Long cells medium to elongated with parallel, slight to moderately undulating, side walls. Silico-suberose couples between successive long cells. No bulliform cells. *Stomata*: absent in alpine form (Figs 22-24) and in those typical *M. stricta* specimens with hypodermal sclerenchyma layer (Fig. 13). Low dome-shaped, 1-2 files of stomata in centre of each intercostal zone; files adjacent to one another. One interstomatal cell between successive stomata. *Intercostal short cells*: silico-suberose couples; cork cell tall and narrow to crescentic; occur between most intercostal long cells. *Papillae*:

TABLE 1.—The differences in leaf anatomy and spikelet morphology between the different forms of *Merxmuellera stricta*

Character	Typical <i>M. stricta</i> form	Cathedral Peak form	Drakensberg form	Alpine form
1. Outline of lamina	1. Permanently infolded	1. Permanently infolded	1. Infolded but regularly opens to 180°	1. Infolded but opening to 45° possible
2. Number of vbs in leaf section	2. 13 (sometimes 11)	2. 11 (sometimes 9)	2. 9 vbs	2. 9 vbs
3. Adaxial furrows	3a. Slight to medium > ½ leaf thickness 3b. Present between all vbs	3a. Absent 3b. No furrows present	3a. Deep > ½ leaf thickness 3b. A single furrow on either side of median vb only	3a. Medium ½ leaf thickness 3b. Present between all vbs
4. Abaxial furrows	4. Single furrow on either side of median vb	4. Slight undulations associated with all vbs	4. Absent except when leaf open	4. Absent
5. Phloem	5. Usually divided into two groups by intrusive fibres	5. Sometimes exhibits sclerosed phloem	5. No intrusive fibres	5. No sclerosed phloem
6. Adaxial extensions of outer bundle sheath	6a. Parenchymatous grading gradually into fibres 6b. Long, narrow extensions of more than 5 cells	6a. Thin-walled colourless parenchyma 6b. Medium extensions of 4 or less cells	6a. Thickened parenchyma abruptly becoming sclerenchyma 6b. Short, wide extensions of 3 or 4 cells deep	6a. Thick-walled parenchyma decreasing in size to epidermis 6b. Long, wide or narrow extensions of more than 5 cells deep
7. Adaxial sclerenchyma	7. Inversely anchor-shaped with long, thin stem	7. Minute strand only; sometimes absent	7. Small strands narrowing towards base extension	7. Inversely anchor-shaped girder with narrow or wide stem
8. Bulliform cells	8. Poorly developed only at base of furrow on either side of median vb	8. Absent	8. Well-developed fan shaped groups at base of furrow on either side of median vb	8. Poor to well developed fan shaped groups in the bases of all furrows
9. Epidermal hairs	9. Micro-hairs only; rare	9. Micro-hairs only	9. Micro-hairs but sometimes macro-hairs occur	9. Micro-hairs, macro-hairs and prickles common
10. Silica body shape	10. Rounded or elliptical	10. Dumb-bell shaped	10. Dumb-bell shaped but round in a few specimens	10. Rounded to elliptical but enfolded by crescentic cork cell
11. Lower glume length	11. (11–) 15,2 mm (–22)	11. (9–) 10,7 mm (–12)	11. (14–) 17,8 mm (–22)	11. (10–) 12,2 mm (–14)
12. Length of lower lemma awn	12. (9–) 12,5 mm (–16)	12. (8–) 9,8 mm (–11)	12. (8–) 12,0 mm (–14)	12. (5,0–) 5,5 mm (–6,5)
13. Hairs on back of lemma at point of insertion of awn	13. Glabrous; occasionally very sparse, scattered hairs present	13. Densely hairy; hairs 2–3,2 mm long	13. Always glabrous	13. Sparsely hairy; hairs up to 2 mm long

absent. *Prickle-hairs*: only present on alpine form (Fig. 22) (Table 1). Barbs short. *Micro-hairs*: present but very rare in typical *M. stricta* and then only in specimens with intercostal zones; common in other three "forms". Bicellular, elongated (especially in alpine form); basal cell slightly longer than distal cell; tapering distal cell thin-walled (Fig. 18). *Macro-hairs*: absent except on all specimens of alpine form; occur in groove on either side of median vb in one specimen of Drakensberg form (Fig. 19). Unicellular, inflexible; 2–3 specialized epidermal cells associated with base of hair; base somewhat swollen in relation to hair thickness. *Silica bodies*: differ in different "forms" (Table 1). Costal bodies rounded or elliptical in typical *M. stricta* (Figs 14 & 15) and in certain specimens of Drakensberg form; dumb-bell shaped in Drakensberg and Cathedral Peak form (Figs 18, 20, 21); small rounded to elliptical and associated with crescentic cork cell in alpine form (Figs 22 & 24). Granules present. Width same as adjacent costal long cells except in alpine form. *Costal cells*: silica cells alternate with costal short cells except in alpine form where silico-suberose couples alternate with costal short cells; files with silica cells alternate with files of costal long cells in all forms except alpine form.

Specimens examined.

Typical *M. stricta* form

CAPE.—3119 (Calvinia): Van Rhyns Pass (–AC), *Ellis* 1139, 1140; Kobe Mts (–CA), *Ellis* 2445, 2447*. 3126 (Queenstown): Bushmanhoek Pass (–AD), *Ellis* 2577*; Hangklip Mt (–DD),

Roberts 2034*. 3218 (Clanwilliam): Pakhuis Pass (–BB), *Ellis* 1705*. 3219 (Wuppertal): Pakhuis Pass (–AA), *Ellis* 1151, 1156; Buffelberg Pass (–CA), *Ellis* 1189. 3225 (Somerset East): Grootfontein valley (–CB), *Van der Walt* 184*. 3318 (Cape Town): Jonkershoek, Stellenbosch (–DD), *Ellis* 2241, 2242, 2258. 3319 (Worcester): Gydoberg (–AD), *Ellis* 2476*; Karoo-poort, Ceres (–BC), *Hafström & Acocks* 100*. Franschhoek Pass (–CD), *Ellis* 687, 688. 3320 (Montagu): 23 km from Barrydale on road to Montagu (–DC), *Ellis* 643. 3322 (Oudtshoorn): Swartberg (–AC), *Ellis* 2579*; Robinsons Pass (–CC), *Ellis* 2583*. 3323 (Willowmore): Uniondale (–CA), *Ellis* 1641*. 3325 (Port Elizabeth): Gamtoos Valley (–CC), *Acocks* 16112. 3326 (Grahamstown): Peddie (–BC), *Fairall* 240. 3418 (Simons-town): Red Hill (–AB), *Ellis* 2317, 2318. 3419 (Caledon): Kleinmond (–AC), *Ellis* 2514, *Van Heerden* 75. 3420 (Bredasdorp): Bredasdorp (–AA), *Ellis* 1265*.

Cathedral Peak form (*M. guillarmodiae*)

O.F.S.—2828 (Bethlehem): Golden Gate National Park, Brandwag Peak (–DA), *Ellis* 2371, 2372.

NATAL.—2829 (Harrismith): Royal Natal National Park (–CB), *Galpin* 10357; Cathedral Peak Forest Reserve (–CC), *Killick* 1110†, 1576†, *Ellis* 3289, 3295, 3297. 2929 (Underberg): Giants Castle Game Reserve (–AB), *Trauseld* 833; Nyiginye (–BA), *Du Toit* 2516; Highmoor Forest Reserve (–BC), *Du Toit* 2500.

Drakensberg form (*M. stricta*)

NATAL.—2829 (Harrismith): Cathedral Peak Forest Reserve (–CC), *Ellis* 1428, 3290, 3299. 2929 (Underberg): Giants Castle Game Reserve, Bannermans Pass (–AD), *Ellis* 3318, 3321; Loteni Game Reserve (–DA), *Ellis* 3322.

*Specimens with continuous abaxial hypodermal sclerenchyma layer and without stomata.

† Specimens cited by Conert (1975) as being *M. guillarmodiae*.

LESOTHO.—2929 (Underberg): Sehlabathebe National Park (—CC), *Du Toit* 2631, 2642.

CAPE.—3028 (Matatiele): Quachas Nek (—BA), *Ellis* 243*; Ramatselisonek (—BB), *Acocks* 22069. 3226 (Fort Beaufort): Great Winterberg (—AD), *Story* 4522.*

Alpine form (*M. guillarmodiae*)

NATAL.—2829 (Harrismith): Cathedral Peak Forest Reserve, summit above Windy Gap (—CC), *Ellis* 1393, 3181, 3182, 3308. 2929 (Underberg): Giants Castle Game Reserve, summit of Bannermans Pass (—AD), *Ellis* 3317; top of Sani Pass (—CA), *Du Toit* 2206, 2242, 2286.

LESOTHO.—2828 (Bethlehem): Butha Buthe (—CC), *Roberts* 5844, *Lubke* 305; Tsehlanyane valley (—CD), *Jacot-Guillarmod* 3727†, 3734†.

CAPE.—3027 (Lady Grey): Doodmans Kranz, Barkly East (—DC), *Galpin* 6906†. 3028 (Matatiele): Quachas Nek, Temrock Peak (—BA), *Liebenberg* 5729.

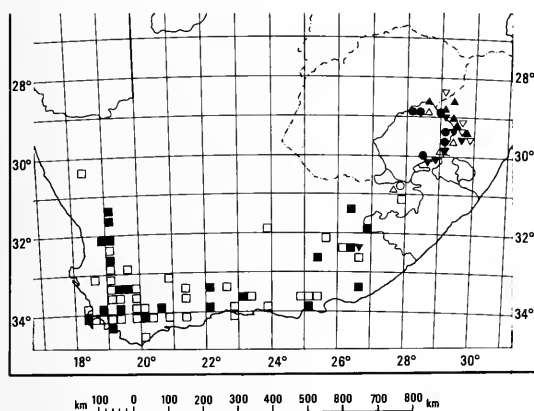


FIG. 33.—Distribution of *Merxmüllera stricta* in South Africa. □—typical *M. stricta*; △—Cathedral Peak form; ▽—Drakensberg form; ○—Alpine form. Shaded symbols represent localities of specimens studied anatomically. Compiled from specimens at the National Herbarium, Pretoria (PRE).

DISCUSSION AND CONCLUSIONS

All the specimens examined in this study have the lateral first order vascular bundles located adjacent to one another and lack the single third order bundle interspaced between them which is characteristic of *M. disticha* (Ellis, 1980). *M. dura*, considered to be closely allied to *M. stricta* (Chippindall, 1955; De Wet, 1960), does not share this characteristic and has, therefore, been excluded from the present considerations.

Anatomically the leaf structure of the typical *M. stricta* form is remarkably constant throughout its wide distributional area (Fig. 33). The only anatomical difference worthy of mention is the development of a continuous abaxial hypodermal sclerenchyma layer (Fig. 1) with the resultant exclusion of the intercostal zones and stomata (Fig. 13). This structure was present in 40% of the specimens examined in this study, and occurs in plants from widely scattered localities, throughout the range of this form, and does not appear to be correlated with any obvious environmental factor. Morphologically there is a definite tendency for these specimens to have shorter glumes [(11–) 12.1 mm (–15)] than the remainder of the typical *M. stricta* specimens [(15–) 17.5 mm (–22)]. These two characters, therefore, appear to be con-

stantly linked and, on the basis of glume length, these shorter spikelets tend to resemble the Cathedral Peak form of *M. guillarmodiae* (Table 1). However, the *M. stricta* form has distinctly longer awns—averaging 11.1 mm as against 9.8 mm for the Cathedral Peak form. This form, however, does not have a continuous hypodermal sclerenchyma layer (Fig. 4) and has numerous stomatal files (Figs 16–18).

The anatomy of the Cathedral Peak form is unmistakable, due to the shape of the adaxial groove which lacks ribs and furrows, (Figs 4–6) and due to the occurrence of dumb-bell shaped silica bodies (Figs 16–18). This type of anatomical structure appears to be strongly correlated with *M. guillarmodiae* spikelet characters, such as the presence of hairs on the back of the lemma up to the point of insertion of the central awn (Conert, 1975). However, as Conert (1975) points out the hair arrangement of the cited Cathedral Peak form specimens (Killick 1100, 1576) resembles that of *M. guillarmodiae*, but the hairs themselves, are longer. The typical *M. guillarmodiae* (alpine form) specimens examined have hairs up to 2.0 mm in length with the lemmas being sparsely hairy but the Cathedral Peak form specimens are densely hairy on the back of the lemmas with the hairs being from 2.0–3.2 mm long.

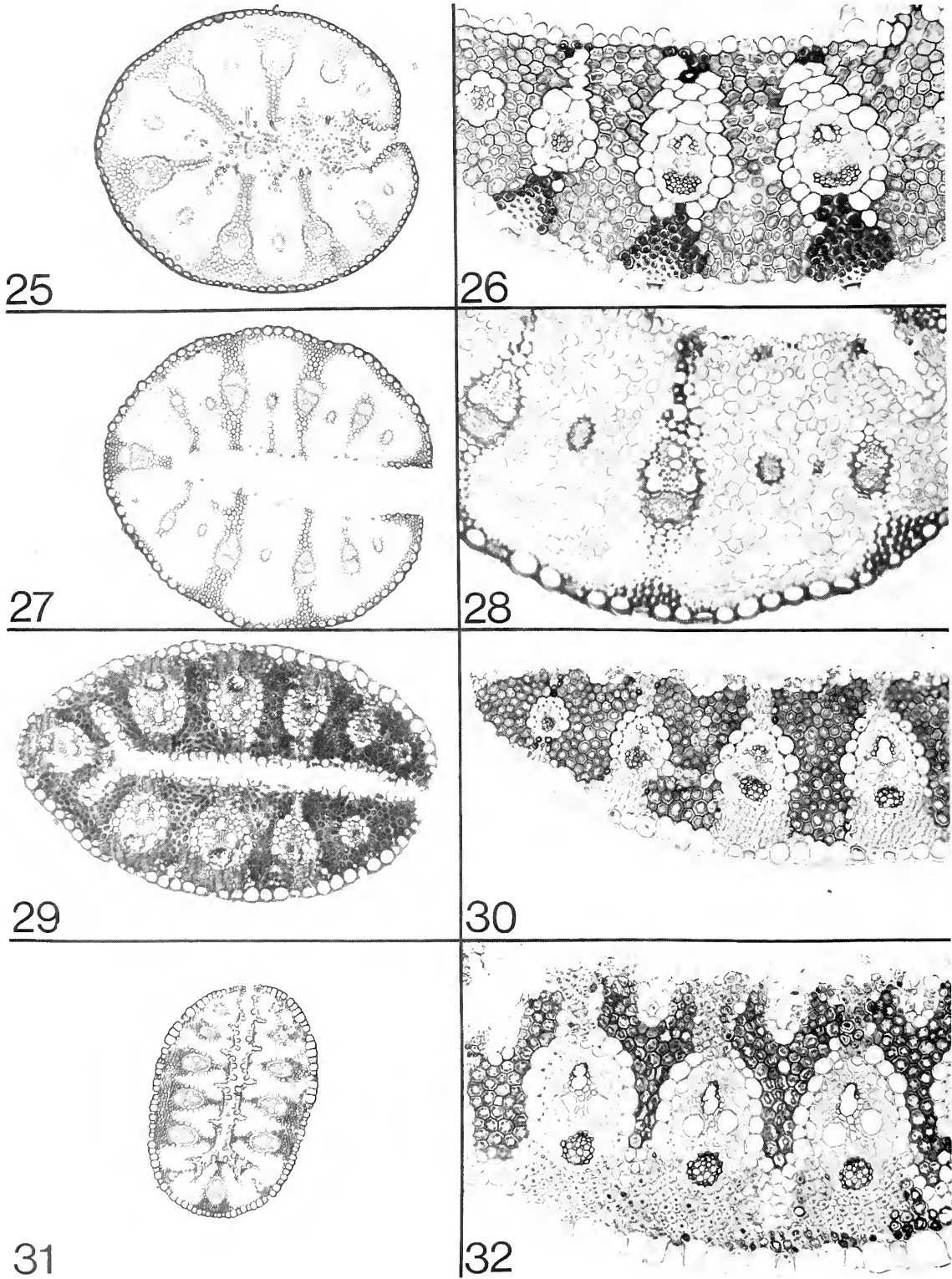
All morphological indications are, therefore, that this Cathedral Peak form is closely linked to the typical *M. guillarmodiae* or alpine form. However, one specimen, *Trauseld* 833, does not exhibit any of these *M. guillarmodiae* spikelet characteristics. Although the adaxial groove and silica bodies conform, it differs anatomically from the remainder of the Cathedral Peak form sample in that it lacks adaxial bundle sheath extensions and thus the mesophyll distribution is continuous adaxially and not restricted to separate tall and narrow groups (Fig. 6). This specimen was collected at Giants Castle and, although this area was revisited, no plants with Cathedral Peak form anatomy or morphology were located. The Drakensberg form, which *Trauseld* 833 resembles morphologically, is common in this area, but all specimens collected had the distinctive Drakensberg form anatomy. Specimens, conforming anatomically and morphologically with the Cathedral Peak form, do occur at Highmoor to the south of Giants Castle, e.g. *Du Toit* 2500.

Further collections from the southern Drakensberg are required to help clarify the relationships of this Cathedral Peak form. It has been grouped under *M. guillarmodiae* (Conert, 1975) together with the alpine form, which it closely resembles morphologically. Anatomically, however, it has most in common with the Drakensberg form. Both these latter “forms” have similar sclerenchyma girders and bundle sheath extensions but, most significantly, both have dumb-bell shaped silica bodies.

The Drakensberg form, on the other hand, although resembling the Cathedral Peak form anatomically, differs significantly morphologically. The back of the lemmas are glabrous along the centre, as in typical *M. stricta*, and the lower glumes are much longer (Table 1). Anatomically the most important difference is the two deep adaxial furrows on either side of the median vascular bundle (Fig. 7) and the laminae are capable of opening to 180° (Fig. 9) especially during conditions of low irradiance. This ability is undoubtedly functionally significant and was possibly partly responsible for the relative success of this Drakensberg form in the north-eastern mountains.

* Specimens with round or elliptical silica bodies.

† Specimens cited by Conert (1975) as being *M. guillarmodiae*.



FIGS 25–32.—A comparison between the leaf anatomy of the setaceous-leaved, summer rainfall *Pentaschistis* species with the anatomy of the leaves of the *Merxmuellera stricta* group. 25, *Pentaschistis basutorum*, Ellis 2368, $\times 160$. Note arrangement of large and small vascular bundles. 26, *Merxmuellera guillarmodiae*, Ellis 3289, $\times 400$. Detail of mesophyll and bundle sheath structure typical of the *M. stricta* group. 27–28, *Pentaschistis fibrosa*. (27, Du Toit 646, $\times 160$, note vascular bundle arrangement; 28, Du Toit 2301, $\times 400$, outer bundle sheath cells thin-walled and inconspicuous.) 29–30, *Pentaschistis tysonii*. (29, Ellis 3302, $\times 250$, third order bundles absent; 30, Ellis 3319, $\times 400$, bundle sheath cells distinct.) 31–32, *Pentaschistis* sp. (31, Ellis 1409, $\times 100$, no third order bundles between lateral first order bundles; 32, Ellis 3292, $\times 400$.)

This anatomical difference, although distinct and consistent, may, however, not be as significant as it initially appears. It can be simply explained by opposite developmental trends in respect of only a single character—a single adaxial furrow on either side of the median vascular bundle. The epidermis also closely resembles that of the Cathedral Peak form as both have dumb-bell shaped silica bodies (Figs 16–21).

The anatomical indications are, therefore, that the Drakensberg form resembles the Cathedral Peak form more closely than either of the other two forms. These similarities are not corroborated by spikelet structure, however, and in this respect the Drakensberg form displays typical *M. stricta* structure.

Some Drakensberg form specimens from the eastern Cape (Ellis 243; Story 4522), however, anatomically demonstrate this relationship with typical *M. stricta*. These specimens have round silica bodies, with characteristic *M. stricta* type epidermal structure but in section the anatomy is typical of the Drakensberg form. This observation, therefore, provides an important clue as to the affinities of this form and provides an anatomical link to support the morphological evidence. A degree of morphological and anatomical gradation appears to occur between these two forms in the areas of sympatry in the north-eastern Cape and once again further collecting is required to help confirm affinities between the Drakensberg, Cathedral Peak and typical *M. stricta* forms.

The anatomy of the alpine form specimens compares very favourably with that of the type specimen of *M. guillarmodiae* (Jacot-Guillarmod 3734). This form appears to be distinct, both anatomically and morphologically, from *M. stricta* (Conert, 1975) although the Cathedral Peak form is intermediate in most spikelet characters (Table 1). In addition it has specialized habitat requirements, being restricted to the higher alpine zone of the Drakensberg, often associated with boggy conditions. It is, therefore, not spatially associated with any of the other forms.

This alpine form of *M. guillarmodiae* exhibits striking resemblances, in habitat preferences, growth form and anatomy, with the alpine bog form described in *M. disticha* (Ellis, 1980). Anatomical similarities are rib and furrow distribution and form, mesophyll configuration and epidermal structure. The only difference is in the pattern of arrangement of the various orders of vascular bundle along the width of the lamina. This arrangement differs in the two "forms" but corresponds with the patterns found in either typical *M. stricta* or typical *M. disticha*. This difference is correlated with differences in inflorescence characters—a contracted panicle in *M. stricta* and a distichous spike in *M. disticha*—and appears to indicate the relationships of the alpine "forms". This seems to be an excellent example of convergent evolution in response to similar environmental conditions.

The most obvious morphological differences between the specimens of the four "forms" of *M. stricta*, recognized and examined in this study, are briefly summarized in Table 1. Typical *M. stricta* and the Drakensberg form have significantly longer lower glumes than do the alpine and Cathedral Peak forms. The longer glumes are associated with longer awns on the lower lemma except in the Cathedral Peak form which is intermediate between the alpine form and the other two. The Cathedral Peak and typical *M. stricta* forms are glabrous on the back of

the lower lemma along the central vein up to the base of the central awn, although, occasionally, a few scattered hairs may be present in *M. stricta* type specimens. In both the alpine and Cathedral Peak forms the back of the lemma is hairy—sparsely hairy with hairs up to 2 mm long in typical *M. guillarmodiae* (the alpine form) but densely hairy with longer hairs (2.0–3.2 mm long) in the Cathedral Peak form.

Morphological characters, therefore, indicate two groups in *M. stricta* sens. lat.—the typical *M. stricta* and Drakensberg forms sharing certain characters whereas, the same characters differ considerably in the alpine and Cathedral Peak forms. This grouping is not confirmed by anatomical evidence which indicates close relationships between the Cathedral Peak and Drakensberg forms with typical *M. stricta* and the alpine forms being distinct. However, a few specimens with anomalous anatomy tend to break down the rigid anatomical divisions and, thereby, add substance to the morphological grouping.

The acceptance of the morphological groupings as reflecting affinities, implies that silica body structure is of no significance in this instance. This would normally be considered unlikely as silica bodies are usually of considerable value taxonomically (Metcalf, 1960). Typical *M. stricta* specimens have classic rounded or elliptical festuroid-type silica bodies whereas, both the Drakensberg and Cathedral Peak forms have panicoid-type, dumb-bell shaped bodies (Clifford & Watson, 1977). All other indications are that typical *M. stricta* and the Drakensberg form are closely related except for silica body shape. In fact, these two "forms" of the same species possess silica bodies supposedly characteristic of different tribal groupings (Prat, 1932; 1936). De Wet (1954, 1956, 1960) notes the mixed character of the epidermis in *M. stricta* but actually refers to the association of micro-hairs (a panicoid character) with the festuroid elliptical silica bodies. Two panicoid epidermal characters may, therefore, occur in *M. stricta* sens. lat. but this is not supported by other anatomical evidence.

The recent description of *M. guillarmodiae* (Conert, 1975) as a separate species initially appears justified on the anatomical evidence presented in this paper. However, certain *M. guillarmodiae* specimens, included here in the Cathedral Peak form, differ dramatically from the type of *M. guillarmodiae* (the alpine form) and, applying the same criteria appear to merit specific status in their own right. The Drakensberg form would then also warrant specific status. This implies that a further two species require description, as is the case in *M. disticha* where an almost identical anatomical situation exists (Ellis, 1980). However, especially in *M. stricta*, these anatomical differences do not correlate very well with morphological differences.

This anatomical diversification within *Merxmuelera* populations in this restricted area of high altitudes and of climatic extremes also appears to be reflected by the description of *M. stereophylla*. (J. G. Anders.) Conert (Anderson, 1962) from *M. drakensbergensis* (Schweick.) Conert. The recognition of *M. stereophylla* was based on morphological and ecological grounds but, in this case, the anatomical differences are minimal in comparison with the differences between the anatomical "forms" of *M. stricta* and *M. disticha*.

In addition, two of the four setaceous-leaved *Pentaschistis* species from this same area, display remarkable anatomical similarities with *M. stricta*

sens. lat. (Figs 25–32). *P. basutorum* Stapf (Fig. 25) and *P. fibrosa* Stapf (Figs 27 & 28) have typical *Pentastichis* anatomy with thin-walled outer bundle sheath cells and somewhat diffuse mesophyll. The bundle sheath extensions and sclerenchyma associated with the third order bundles differ considerably from *M. stricta* sens. lat. (Fig. 26). *P. tysonii* Stapf (Figs 29 & 30) and *Pentastichis* sp. (Figs 31 & 32), on the other hand, display typical *Merxmüllera* type anatomy, and, on anatomical grounds only, appear to have more in common with *Merxmüllera* and especially the *M. stricta* group than they do with *Pentastichis*.

The following *Pentastichis* specimens were examined:

P. basutorum

O.F.S.—2828 (Bethlehem): Golden Gate National Park (–DA), Ellis 2367, 2368, 2369, 2370, 2373; Liebenberg 7454.

P. fibrosa

NATAL.—2829 (Harrismith): Cathedral Peak Forest Reserve (–CC), Ellis 3300; Sentinel (–DB), Du Toit 646. 2929 (Underberg): Highmoor Forest Reserve (–BC), Ellis 3169; Sani Pass (–CB), Du Toit 2301.

P. tysonii

NATAL.—2829 (Harrismith): Cathedral Peak Forest Reserve (–CC), Ellis 3296, 3302; Killick 2280. 2929 (Underberg): Giants Castle Game Reserve, Bannermans Pass (–AD), Ellis 3314, 3319.

Pentastichis sp.

NATAL.—2829 (Harrismith): Cathedral Peak Forest Reserve (–CC), Ellis 1409, 3291, 3292. 2929 (Underberg): Giants Castle Game Reserve, Bannermans Pass (–AD), Ellis 3320.

For the above reasons the description of numerous new *Merxmüllera* species from this summer rainfall area is to be cautioned against for the time being. The indications are that this temperate region of high altitudes has only relatively recently been colonized by these typically winter rainfall grasses from the south. Adaptive radiation appears to be actively continuing and the taxonomic picture is not at all clear. Further studies, especially those of a bio-systematic and autecological nature, are needed, within *Merxmüllera* and closely related genera in the Danthonieae, before reliable taxonomic conclusions can be reached. At present, the assigning of specific rank to any of these anatomical “forms” cannot be fully justified. However, for practical purposes, each of these anatomical “forms”, described in both *M. stricta* and *M. disticha* (Ellis, 1980), deserve taxonomic recognition but infraspecific groupings are recommended until the status of this genus in this area is better understood.

In arriving at a final conclusion, it must be remembered, that, in both *M. stricta* and *M. disticha*, the anatomical differences between the “forms” are of considerable magnitude, disjunct and are correlated with other anatomical, morphological and ecological characteristics. In many instances these differences are, therefore, greater than are those between other *Merxmüllera* species and even between some of the genera of the Danthonieae.

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UITTREKSEL

Die anatomiese struktuur, van die blaar in dwarsnee en die abaksiale epidermis, van Merxmüllera stricta (Schr.) Conert word beskryf en geïllustreer. Vier afsonderlike anatomiese “vorme” word erken: die tipiese M. stricta vorm, die Cathedral Peak vorm, die Drakensberg vorm en die alpiene vorm. Die alpiene en Cathedral Peak vorme is onlangs beskryf as M. guillarmodiae Conert (1975). Die mate van anatomiese diversifikasie van al hierdie “vorme” toon 'n ooreenkoms met die toestand wat in M. disticha beskryf is (Ellis, 1980). Populasies van, beide M. stricta en M. disticha, van die Drakensberge, vertoon anatomiese diversifikasie op groot skaal wat ook gekorreleer is met omgewingsfaktore. Boonop is morfologiese verskille ook sigbaar en hierdie anatomiese “vorme” van M. stricta verdien vermoedelik om taksonomiese erkenning te verkry.

REFERENCES

- ACOCKS, J. P. H., 1975. Veld types of South Africa, 2nd ed. *Mem. bot. Surv. S. Afr.* 40: 1–127.
- ANDERSON, J. G., 1962. Notes on African plants: Gramineae. *Bothalia* 7: 419–420.
- CHIPPINDALL, L. K. A., 1955. In D. Meredith, *The grasses and pastures of South Africa*. Johannesburg: CNA.
- CLIFFORD, H. T. & WATSON, L., 1977. *Identifying grasses*. St. Lucia: Univ. of Queensland Press.
- CONERT, H. J., 1970. *Merxmüllera*, eine neue Gattung der Gramineen. *Senckenberg. Biol.* 51: 129–133.
- CONERT, H. J., 1975. *Merxmüllera guillarmodiae* Conert n.sp. *Senckenberg Biol.* 56: 145–152.
- DE WET, J. M. J., 1954. The genus *Danthonia* in grass phylogeny. *Am. J. Bot.* 41: 204–211.
- DE WET, J. M. J., 1956. Leaf anatomy and phylogeny in the tribe Danthonieae. *Am. J. Bot.* 43: 175–182.
- DE WET, J. M. J., 1960. Leaf anatomy and morphology in the South African species of *Danthonia*. *Bothalia* 7: 303–310.
- ELLIS, R. P., 1976. A procedure for standardizing comparative leaf anatomy in the Poaceae. I. The leaf blade as viewed in transverse section. *Bothalia* 12: 65–109.
- ELLIS, R. P., 1979. A procedure for standardizing comparative leaf anatomy in the Poaceae. II. The epidermis as seen in surface view. *Bothalia* 12: 641–672.
- ELLIS, R. P., 1980. Leaf anatomy of the South African Danthonieae (Poaceae). II. *Merxmüllera disticha*. *Bothalia* 13: 185–189.
- METCALFE, C. R., 1960. *Anatomy of the monocotyledons. I. Gramineae*. Oxford: Clarendon Press.
- PRAT, H., 1932. L'Épiderme des Graminées. Étude anatomique et systématique. *Annls Sci. nat. (Bot.) ser. 10* 14: 117–324.
- PRAT, H., 1936. La systématique des Graminées. *Annls Sci. nat. (Bot.) ser. 10* 18: 165–258.

A synecological account of the Suikerbosrand Nature Reserve.

II. The phytosociology of the Ventersdorp Geological System*

G. J. BREDENKAMP† and G. K. THERON‡

ABSTRACT

The vegetation of the Ventersdorp Geological System of the Suikerbosrand Nature Reserve is analysed and classified according to the Braun-Blanquet method. Descriptions of the plant communities include description of habitat features, the identification of differentiating species groups as well as the listing of prominent and less conspicuous species for the tree, shrub and herbaceous layers. The habitat features that are associated with differences in vegetation include altitude, aspect, slope, rockiness of soil surface, soil depth and soil texture.

RÉSUMÉ

COMPTE-RENDU SYNÉCOLOGIQUE DE LA RÉSERVE NATURELLE DU SUIKERBOSRAND. II. PHYTOSOCIOLOGIE DU SYSTÈME GÉOLOGIQUE DE VENTERSDORP

La végétation du système géologique de Ventersdorp dans la Réserve Naturelle du Suikerbosrand est analysée et classée selon la méthode de Braun-Blanquet. Les descriptions des communautés végétales incluent la description des caractéristiques d'habitat, l'identification de groupes d'espèces qui se différencient ainsi que le catalogue des espèces en vue et des espèces moins apparentes dans les strates arborées, arbustives et herbacées. Les caractéristiques d'habitat associées à des différences dans la végétation comprennent l'altitude, l'aspect, la pente, la nature rocheuse de la surface du sol, la profondeur et la texture du sol.

INTRODUCTION

The first part of the account of the synecology of the Suikerbosrand Nature Reserve dealt with the phytosociology of the Witwatersrand Geological System (Bredenkamp & Theron, 1978), while this, the second and final part, deals with the phytosociology of the Ventersdorp Geological System.

THE STUDY AREA

The Ventersdorp System occupies the western part of the Reserve and covers approximately 8 000 ha (60%) of the Reserve (Fig. 1). This system is volcanic in origin (Du Toit, 1954) and includes a chain of mountains with vast, undulating grassland plateaux, 1 800 m to 1 900 m above sea level and flat grassland plains at the foot of the mountains, 1 500 m to 1 650 m

above sea level. Rocky outcrops are found scattered on the plateaux. The north-, northwest- and northeast-facing slopes of the mountains are mostly gentle and covered with grassland. The south-facing slopes, on the contrary, are steep, especially where cliffs of andesitic lava are exposed. These steep, usually rocky slopes are mostly covered with dense bush (Fig. 2). The plateaux are drained by a number of kloofs, some of which cut deeply into the mountains resulting in steep slopes, characteristically covered with woody vegetation. The lower valleys in the bigger kloofs are sheltered and contain deep, fertile clayey soils of alluvial and colluvial origin. The soils of the study area however, are mostly fairly shallow with a sandy clay or sandy clay loam texture.

The climate of the area was described in Part I of this account (Bredenkamp & Theron, 1978).

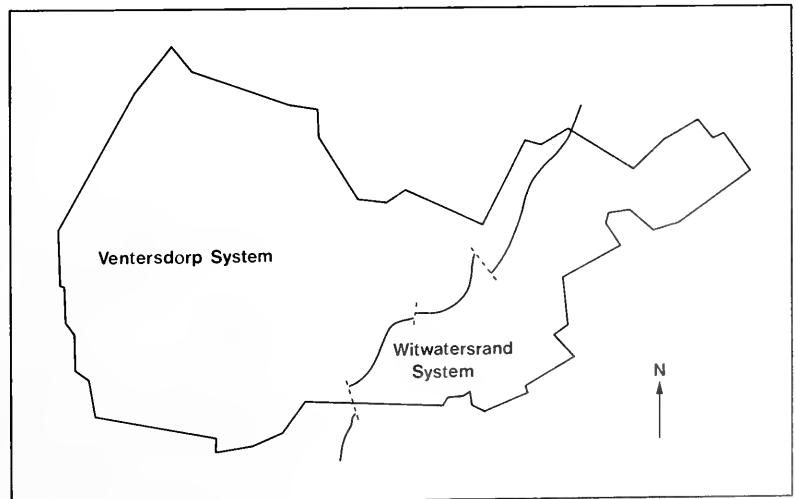


FIG. 1.—A simplified geological map of the Suikerbosrand Nature Reserve.

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Fig. 2.—Dense bush on south-facing slopes of the Ventersdorp System mountains.

METHODS

The methods applied are those used by Bredenkamp & Theron (1978). Thirteen different physiographic and physiognomic units represented in the study area were delineated on aerial photographs. One hundred and ninety three sample plots were divided *pro rata* on an area basis among the thirteen units (Table 1), and were placed at random within these units.

THE PLANT COMMUNITIES

The floristic composition of plant communities is represented in phytosociological Tables 2 & 4 and the prominent species in each community are indicated in Tables 3 & 5. The symbol “P” indicates species covering at least 5% of the area represented in the relevés in at least 25% of the relevés representing a community, while “p” indicates species covering at least 1% of the area represented in the relevés, in at least 50% of the relevés representing a community. The symbol “t” in Tables 2 & 4 equals the symbol “r” in normal Braun-Blanquet tables.

The vegetation may be divided into two major communities:

The *Euclea crispa*—*Rhoicissus tridentata* Bush and Savanna Communities (Tables 2 & 3) and

The *Trachypogon spicatus*—*Themeda triandra* Grassland Communities (Tables 4 & 5).

1. *Euclea crispa*—*Rhoicissus tridentata* Bush and Savanna Communities

These communities are found in the kloofs and valleys and on the foothills and slopes of the mountains within the study area and their floristic composition is represented in Table 2. This vegetation is characterized by the large *Rhoicissus tridentata* species group (Table 2) with *Euclea crispa* as the most prominent species (Table 3) and is divided into five principal communities described under 1.1, 1.2, 1.3, 1.4 and 1.5.

1.1 *Rhus pyroides*—*Leucosidea sericea* Bush and Savanna Communities

These communities include the dense forests in the kloofs, as well as the isolated patches of forest and savanna on the steep south-facing slopes of the mountains. All these communities are characterized by the *Rhus pyroides* species group (Table 2), with *Euclea crispa* and *Rhus pyroides* very prominent.

Two communities each with two variations are distinguished:

1.1.1 *Rhus pyroides*—*Rhamnus prinoides* Forest (Fig. 3).

This dense forest vegetation is characterized by the *Rhamnus prinoides* species group (Table 2) and is mainly found in the sheltered kloofs within the

TABLE 1.—The distribution of the 193 sample plots in the 13 physiographic-physiognomic units

	Physiographic-physiognomic units												
	Bush and savanna						Grassland						
	Kloof	Flats	Slopes				Plateaux		Slopes				Flats
			*N	S	E	W	Rocky	Not rocky	N	S	E	W	
Number of sample plots.....	10	9	19	21	20	11	11	21	11	20	13	7	20

* N=north-facing, etc.

FOL

TABLE 3.—Prominent species in the *Euclea crispa*—*Rhoicissus tridentata* Bush and Savanna Communities

Plant species	Community numbers												
	1.1.1a	1.1.1b	1.1.2a	1.1.2b	1.2	1.3.1	1.3.2	1.3.3a	1.3.3b	1.4	1.5.1	1.5.2	1.5.3
<i>Celtis africana</i>	P	p							p	P			
<i>Myrsine africana</i>	P	P		P									
<i>Rhamnus prinoides</i>	p	P											
<i>Diospyros lycioides</i>	p												
<i>Leucosidea sericea</i>	P												
<i>Ehrharta erecta</i>		P											
<i>Galopina circaeoides</i>		p		P									
<i>Protea caffra</i>			p	P									
<i>Buddleja salviifolia</i>			p										
<i>Cymbopogon marginatus</i>			P		P								
<i>Tristachya hispida</i>				P									
<i>Brachiaria serrata</i>				P									
<i>Harpochloa falx</i>				p									
<i>Senecio isatideus</i>				p									
<i>Hyparrhenia hirta</i>				P									
<i>Rhus pyroides</i>	P	P	P	P					p	P	p		
<i>Maytenus heterophylla</i>			p		P		P			p			
<i>Trachypogon spicatus</i>				P	P					P			
<i>Heteropogon contortus</i>						P							
<i>Canthium mundianum</i>							P						
<i>Pavonia burchellii</i>							p						
<i>Felicia filifolia</i>							p						
<i>Aloe marlothii</i>					p			P					
<i>Heteromorpha arborescens</i>	P								P				
<i>Buddleja saligna</i>							P	P	P				
<i>Rhus leptodictya</i>							p	p	P				
<i>Maytenus polyacantha</i>						p	P	P					
<i>Canthium gilfillanii</i>						P	P	P	P				
<i>Rhoicissus tridentata</i>						P	P	P	P				
<i>Eustachys mutica</i>							P						P
<i>Acacia caffra</i>								P	P				P
<i>Tarchonanthus camphoratus</i>								P		P			
<i>Euclea crispa</i>	P	P	p	p	P	P		P	P	P			
<i>Ziziphus mucronata</i>													
<i>Teucrium capense</i>											p		
<i>Aristida congesta</i>												p	
<i>Cynodon dactylon</i>										p			P
<i>Acacia karroo</i>											P	P	P
<i>Asparagus suaveolens</i>				P	P	P	p		P	P	P	P	P
<i>Themeda triandra</i>							p		P	P	P	P	P
<i>Eragrostis curvula</i>							p	p					
<i>Isoglossa grantii</i>	P	p					P					p	

Explanation of "P" and "p" in text.

FIG. 3.—*Rhus pyroides*—*Rhamnus prinoides* Forest in a kloof.

study area, but isolated patches are found on steep south-facing slopes. According to the Fosberg (1967) classification, this community is an evergreen broad sclerophyll forest (1A1/6).

Two variants are distinguished:

(a) *Rhus pyroides*—*Rhamnus prinoides*—*Cassinopsis ilicifolia* Variant

This variation is characterized by the presence of the *Dolichos falciformis* species group and is negatively associated with the *Acacia karroo* species group (Table 2). It occurs in sheltered moist kloofs on sandy loam soils at an altitude of 1 740–1 770 m.

The total canopy cover of the vegetation is 90–95% and an average of 28 species was recorded per relevé.

The tree stratum is 8–10 m tall and has a canopy cover of 70–90%. *Euclea crispa* (100%)*, *Rhus pyroides* (100%), *Diospyros lycioides* (100%) *Leucosidea sericea* (80%), *Rhamnus prinoides* (80%), *Heteromorpha arborescens* (80%), and *Celtis africana* (80%) are prominent trees (Table 3). *Cassinopsis ilicifolia* (80%), *Buddleja salviifolia* (60%), *Olea africana* (60%), *Cussonia paniculata* (40%) and *Maytenus heterophylla* (40%) are also often present.

A definite shrub stratum, 2 m tall and with a canopy cover of 30–50% is dominated by *Diospyros lycioides* (100%) and *Myrsine africana* (Table 3), both forming very dense thickets locally. Other shrubs include *Diospyros whyteana* (80%), *Psoralea polysticta* (80%), *Grewia occidentalis* (60%) and *Calpurnia intrusa* (40%). *Artemisia afra* (60%) and *Felicia filifolia* (40%) are conspicuous in less dense patches.

Lianes are well represented in the tree and shrub strata, with *Rhoicissus tridentata* (100%), *Dolichos falciformis* (100%), *Clematis brachiata* (80%), *Rubia petiolaris* (40%) and *Asparagus africanus* (40%) often present.

The herbaceous layer is fairly open, with 20–50% canopy cover, and is mostly less than 0.2 m tall, but prominent individual shrublets of *Isoglossa grantii* (40%) and *Clutia hirsuta* (40%) may be up to 1 m tall. *Galopina circaeoides* (100%), *Ehrharta erecta* (80%), *Senecio isatideus* (80%), *Achyranthes aspera* (80%), *Argyrolobium rupestre* (60%), *Carex spicato-paniculata* (40%), *Bromus leptoclados* (40%) and other species are present.

(b) *Rhus pyroides*—*Rhamnus prinoides*—*Acacia karroo* Variant

This variation occurs in drier kloofs, on clay loam soils at an altitude of less than 1 740 m. It is characterized by a negative association with the *Dolichos falciformis* species group, but the presence of some species of the *Acacia karroo* species group (Table 2). An average of 27 species was recorded per relevé, and the total canopy cover for this community is 80–95%.

The tree stratum is often 10 m tall, with a canopy cover of 50–90%. *Euclea crispa* (100%), *Rhus pyroides* (89%), *Celtis africana* (78%) and *Rhamnus prinoides* (78%) are prominent trees (Table 3). Other trees include:

<i>Heteromorpha arborescens</i>	67%	<i>Fagara capensis</i>	33%
<i>Acacia karroo</i>	67%	<i>Cussonia paniculata</i>	33%
<i>Maytenus heterophylla</i>	67%	<i>Pittosporum viridiflorum</i>	22%
<i>Olea africana</i>	56%	<i>Rhus leptodictya</i> ...	22%
<i>Buddleja salviifolia</i> ...	56%	<i>Ziziphus mucronata</i>	22%
<i>Leucosidea sericea</i> ...	44%		

* In the following treatment where the symbol % follows the name of a species, the figures indicate the constancy of that species in the community.

A well-defined shrub stratum, 2 m tall and with a canopy cover of 40–60% occurs in this community. Prominent shrubs include *Rhus pyroides* (89%), *Myrsine africana* (78%), *Acacia karroo* (67%) and *Buddleja salviifolia* (56%) (Table 3). Other conspicuous shrubs include *Asparagus suaveloens* (56%), *Diospyros whyteana* (44%), *Grewia occidentalis* (44%), *Lantana rugosa* (33%), *Calpurnia intrusa* (33%), *Rubus rigidus* (22%), *Lippia javanica* (22%) and *Diospyros austro-africana* (22%).

Lianes often present in the tree and shrub strata include *Rhoicissus tridentata* (89%), *Clematis brachiata* (78%), *Rubia petiolaris* (44%), *Dolichos falciformis* (22%), *Asparagus aethiopicus* (22%), *A. africanus* (22%) and *A. asparagoides* (22%).

The herbaceous layer varies considerably. It is mostly up to 0.5 m tall, and the canopy cover varies from 5%, where the upper strata are dense, to 70%, where the upper strata are more open. Prominent herbs include *Ehrharta erecta* (100%), *Galopina circaeoides* (78%) and *Isoglossa grantii* (78%) (Table 3) but *Achyranthes aspera* (78%) and *Teucrium capense* (67%) are locally conspicuous. Other herbs which may be present include:

<i>Eragrostis curvula</i> ...	44%	<i>Argyrolobium rupestre</i>	22%
<i>Themeda triandra</i> ...	33%	<i>Cuscuta campestris</i>	22%
<i>Solanum rigescens</i> ...	33%	<i>Asplenium adian-tum-nigrum</i>	22%
<i>Cheilanthes eckloniana</i>	33%	<i>Commelina erecta</i> ...	22%
<i>Hyparrhenia hirta</i> ...	22%	<i>Solanum retroflexum</i>	22%
<i>Eragrostis pseudosclerantha</i>	22%	<i>Oxalis depressa</i>	22%
<i>Chlorophytum bowkeri</i>	22%	<i>Senecio isatideus</i> ...	22%

1.1.2 *Rhus pyroides*—*Protea caffra* Savanna

This community is characterized by the *Berkheya setifera* species group (Table 2), and can further be distinguished from the *Rhus pyroides*—*Rhamnus prinoides* Forest by the presence of the *Brachiaria serrata* species group. It occurs on south-facing slopes, mostly at fairly high altitudes of more than 1 700 m above sea level. The vegetation is an evergreen broad sclerophyll shrub savanna (1K1/2) of Fosberg (1967).

Two variants are distinguished:

(a) *Rhus pyroides*—*Protea caffra*—*Chrysanthemoides monilifera* Variant

This variation occurs on very steep (often more than 20°) rocky south to southeast facing slopes, and is distinguished from the *Rhus pyroides*—*Protea caffra*—*Harpochloa falx* Variant by the absence of the *Harpochloa falx* species group (Table 2).

An average of 34 species was recorded per relevé and the total canopy cover of the vegetation varies between 60% and 90%.

The trees are up to 6 m tall, and grow singly or in groups to form scattered bush thickets. Although *Rhus pyroides* (80%), *Euclea crispa* (80%) and *Maytenus heterophylla* (80%) are the most prominent trees (Table 3), *Protea caffra* (40%) is conspicuous in this community. Other trees which are often present in this community include *Leucosidea sericea* (60%), *Buddleja salviifolia* (60%) and *Celtis africana* (40%).

Although many shrubs occur in this community, their total canopy cover never exceeds 30%. *Diospyros lycioides* (100%) and *Myrsine africana* (60%) are the most prominent shrubs. Other shrubs include *Cassine aethiopica* (60%), *Rhus eckloniana* (40%), *Canthium gilfillanii* (40%), *Diospyros whyteana* (40%), *Felicia*

filifolia (40%), *Psoralea polysticta* (40%) and *Celtis africana* (40%).

The lianes *Rhoicissus tridentata* (100%) and *Clematis brachiata* (100%) are constantly found in the tree and shrub strata.

The herbaceous layer is often up to 1 m tall, and has a canopy cover of up to 80%. The tall *Cymbopogon marginatus* (80%) is generally conspicuous, but *Eragrostis curvula* (40%) and especially *Hyparrhenia hirta* (40%) are locally prominent (Table 3). Other herbaceous plants which occur in at least two of the five relevés representing this community include:

Pellaea calomelanos...	80%	Hibiscus aethiopicus	
Rubia petiolaris.....	80%	var. ovatus.....	60%
Cheilanthes hirta.....	80%	Helichrysum mico-	
Berkheya setifera.....	60%	neifolium.....	40%
Chrysanthemoides		Koeleria cristata....	40%
monilifera.....	60%	Senecio isatideus....	40%
Rhus discolor.....	60%	Argyrobolium rupes-	
Athrixia elata.....	60%	tre.....	40%
Brachiaria serrata....	60%	Tephrosia capensis..	40%
Setaria nigrirostris....	60%	Themeda triandra....	40%
Crabbea acaulis.....	60%	Aloe davyana.....	40%
Ledebouria margi-		Indigofera hilaris...	40%
nata.....	60%		

(b) *Rhus pyroides*—*Protea caffra*—*Harpochloa falx* Variant

This variation occurs in scattered patches on southwest-facing slopes that are not as steep as those of the previous community.

The *Harpochloa falx* species group (Table 2) is characteristic of this community. An average of 44 species was recorded per relevé and the total canopy cover of the vegetation is more than 90%.

The canopy of the tree stratum is often less than 10%, and *Protea caffra* (100%), *Rhus pyroides* (75%) and *Euclea crispa* (75%) are the most prominent trees (Table 3). Individuals of *Rhus leptodictya* (50%), *Celtis africana* (50%) and *Cussonia paniculata* (50%) are found scattered in this community.

Shrubs are poorly represented but *Rubus rigidus* (100%) is constantly present and forms impenetrable thickets locally. *Rhus eckloniana* (100%), *Diospyros lycioides* (100%), *Myrsine africana* (75%) and *Lippia javanica* (50%) are usually small inconspicuous shrublets.

The herbaceous layer is well defined, up to 0.7 m tall, and is usually very dense with a canopy cover of 70–90%. *Trachypogon spicatus* (100%) dominates the herbaceous layer, while *Harpochloa falx* (100%), *Brachiaria serrata* (100%), *Senecio isatideus* (75%), *Tristachya hispida* (75%), *Hyparrhenia hirta* (75%) and *Themeda triandra* (50%) are locally very conspicuous (Table 3). In spite of the relatively low canopy cover of *Berkheya setifera* (100%), *Rhus discolor* (100%) and *Aster pegeriae* (100%) they are constantly present and very conspicuous. The following other herbs were present in at least two of the relevés representing the community:

Schistostephium cra-		Eragrostis curvula...	75%
tae gifolium.....	100%	Rubia petiolaris.....	75%
Cheilanthes hirta.....	100%	Pentania prunelloi-	
Helichrysum miconi-		des.....	50%
folium.....	75%	Indigofera zeyheri...	50%
Monsonia attenuata...	75%	Argyrobolium ru-	
Setaria nigrirostris...	75%	pestre.....	50%
Tephrosia capensis...	75%	Ledebouria sp.....	50%
Phyllanthus parvulus	75%	Acalypha punctata..	50%
Aristea woodii.....	75%	Achyranthes aspera	50%
Becium obovatum....	75%	Crabbea acaulis....	50%
Vernonia natalensis..	75%		

1.2 *Euclea crispa*—*Maytenus heterophylla*—*Setaria nigrirostris* Savanna

This community is situated on north-facing slopes of kloofs at an altitude of 1 740–1 800 m. Scattered trees and shrubs occur, but the herbaceous layer is dense and well defined. The vegetation is an evergreen broad sclerophyll shrub savanna (1K1/2) of Fosberg (1967). The community is characterized by the *Vernonia oligocephala* species group (Table 2). The simultaneous presence of the *Phyllanthus parvulus* and *Brachiaria serrata* species groups, as well as *Aloe marlothii* (Table 2) is another characteristic feature of this community. The total canopy cover of the vegetation is 60–90% and an average of 33 species was recorded per relevé.

The tree stratum is sparse, with a canopy cover of less than 20%. The trees are 3–4 m tall. *Aloe marlothii* (66%), *Euclea crispa* (66%) and *Maytenus heterophylla* (66%) are the most prominent trees (Table 3), while *Ziziphus mucronata* (66%) and *Cussonia paniculata* (66%) are often present.

The shrub stratum is also sparse, but its canopy cover is locally as high as 25%. As in the case of the tree stratum, the most prominent species are *Aloe marlothii* (100%), *Euclea crispa* (100%) and *Maytenus heterophylla* (100%), but *Rhus eckloniana* (100%), *Diospyros lycioides* (66%), *Lippia javanica* (66%) and *Lantana rugosa* (66%) are also common.

The herbaceous layer is well defined, up to 0.5 m tall and has a canopy cover of 60–80%. *Hyparrhenia hirta* (100%) and *Themeda triandra* (66%) are the most prominent species, but *Trachypogon spicatus* (66%) and *Cymbopogon marginatus* (66%) are also very conspicuous (Table 3). Other herbs present in at least two of the three relevés representing this community include the following:

Setaria nigrirostris...	100%	Becium obovatum...	66%
Vernonia oligocephala	100%	Diheteropogon am-	
Aloe davyana.....	100%	plectens.....	66%
Pellaea calomelanos..	100%	Pentania angusti-	
Ledebouria marginata	100%	folia.....	66%
Athrixia elata.....	66%	Hypoxis rigidula....	66%
Brachiaria serrata....	66%	Anthospermum ri-	
Chaetacanthus bur-		gidum.....	66%
chellii.....	66%	Elephantorrhiza ele-	
Phyllanthus parvulus	66%	phantina.....	66%

1.3 *Euclea crispa*—*Maytenus polyacantha*—*Canthium gilfillanii* Bush and Savanna Communities

These communities include the dense bush and open savannas which mostly occur on north-, west- and east facing slopes of the mountains in the western part of the study area. The *Maytenus polyacantha* species group (Table 2) is characteristic of these communities, and a prominent feature of it is that *Maytenus polyacantha* and *Canthium gilfillanii* locally form impenetrable thickets.

Three communities are distinguished and described under 1.3.1, 1.3.2 and 1.3.3.

1.3.1 *Maytenus polyacantha*—*Heteropogon contortus* Savanna

This community (Fig. 4) is mostly found on rocky slopes of less than 22° between 1 600 and 1 700 m above sea level. Rocks cover 21–60% of the soil surface. The vegetation of relevés 36, 40, 73 and 75, situated on somewhat steeper slopes, included species from the *Buddleja saligna* and *Aloe marlothii* species groups (Table 2). An affinity with the *Acacia caffra*—



FIG. 4.—*Maytenus polyacantha*—*Heteropogon contortus* Savanna.

Aloe marlothii Bush, normally found on the steeper slopes, is thus indicated.

The community is characterized by the *Heteropogon contortus* species group (Table 2). The trees and shrubs often occur in scattered bush clumps. The vegetation is an evergreen broad sclerophyll scrub (1B1/4) of Fosberg (1967). The total canopy cover varies from 60–95% and an average of 35 species was recorded per relevé.

The tree stratum is up to 5 m tall with a canopy cover of 5–40%. This stratum is often dominated by *Canthium gilfillanii* (94%) and *Euclea crispa* (89%) (Table 3). These two trees often form groups of dense thickets. Other trees present in this community include *Fagara capensis* (78%), *Cussonia paniculata* (61%), *Celtis africana* (44%), *Dombeya rotundifolia* (44%), *Maytenus heterophylla* (39%), *Ehretia rigida* (27%), *Rhus leptodictya* (22%) and *Ziziphus mucronata* (22%).

The shrub stratum has 10–40% canopy cover, with *Maytenus polyacantha* (78%) the most prominent shrub (Table 3). *Canthium gilfillanii* (94%) and *Euclea crispa* (89%) are also often very prominent (Table 3), in which case it becomes difficult to differentiate between the tree and shrub strata. Other shrubs include:

<i>Fagara capensis</i>	72%	<i>Maytenus hetero-</i>	
<i>Diospyros lycioides</i> ..	72%	<i>phylla</i>	39%
<i>Cassine aethiopica</i> ...	67%	<i>Grewia occidentalis</i>	22%
<i>Rhus eckloniana</i>	56%	<i>Pavetta assimilis</i> ...	22%
<i>IsoGLOSSA grantii</i>	44%	<i>Tarchonanthus cam-</i>	
<i>Myrsine africana</i>	44%	<i>phoratus</i>	22%
		<i>Carissa bispinosa</i> ...	17%

The liane *Rhoicissus tridentata* (100%) is constantly prominent in the tree and shrub strata, while *Rubia petiolaris* (50%) and *Clematis brachiata* (33%) are locally present.

The herbaceous layer is well developed, 0,5 m tall, with canopy cover often up to 80%. *Heteropogon contortus* (89%) and *Themeda triandra* (89%) are the most prominent species (Table 3), but *Elionurus muticus* (94%) is also very conspicuous. *Commelina africana* (72%) and *Ruellia cordata* (61%) are well

represented in the shade of the dense bush clumps. Other herbs present in this community include:

<i>Aloe davyana</i>	89%	<i>Hyparrhenia hirta</i> ...	39%
<i>Ledebouria</i> sp.....	72%	<i>Trachypogon spi-</i>	
<i>Rhynchelytrum seti-</i>		<i>catus</i>	33%
<i>folium</i>	67%	<i>Cymbopogon margi-</i>	
<i>Eustachys mutica</i>	61%	<i>natus</i>	33%
<i>Brachiaria serrata</i> ...	61%	<i>Setaria nigrirostris</i> ..	28%
<i>Pellaea calomelanos</i> ..	61%	<i>Cheilanthes hirta</i>	28%
<i>Eragrostis curvula</i> ...	56%	<i>Gerbera viridifolia</i> ..	22%
<i>Kalanchoe paniculata</i>	50%	<i>Rhynchosia totta</i> ...	22%
<i>Sida dregei</i>	50%	<i>Senecio oxyriifolia</i> ..	22%
<i>Chaetacanthus bur-</i>		<i>Crassula rubicunda</i>	22%
<i>chellii</i>	44%		

1.3.2 *Euclea crispa*—*Maytenus polyacantha*—*Scolopia zeyheri* Bush

This community occurs in dense, isolated patches on steep northeast- and northwest-facing slopes at an altitude of 1 645–1 690 m. These dense bush clumps are examples of evergreen broad sclerophyll scrub (1B1/4) of Fosberg (1967) and are characterized by the *Canthium mundianum* species group (Table 2), and the prominence of *Euclea crispa* (100%) (Table 2). An average of 22 species was recorded per relevé and the total canopy cover is 70–90%.

The tree stratum is 3–4 m tall and is very dense, with a canopy cover of 60–90%. Together with the very prominent *Euclea crispa* (100%), *Canthium mundianum* (75%), *C. gilfillanii* (75%) and *Rhus leptodictya* (75%) are also prominent trees (Table 3). Other trees include *Scolopia zeyheri* (100%) and *Dombeya rotundifolia* (100%).

The shrub stratum covers 20–40% and is dominated by *Euclea crispa* (100%), *Canthium mundianum* (75%), *C. gilfillanii* (75%), *Felicia filifolia* (100%) and *Maytenus polyacantha* (75%). Other shrubs include *Scolopia zeyheri* (100%), *Lippia javanica* (75%) and *Lantana rugosa* (50%).

Rhoicissus tridentata (100%) is a prominent liane in the tree and shrub strata.

Owing to the dense tree and shrub strata, the herbaceous layer is poorly developed, often not taller than 0,2 m and with a canopy cover of only

5–10%. Conspicuous species present in this layer include:

<i>Commelina africana</i> ...	100%	<i>Trachypogon spica-</i>	
<i>Aloe davyana</i>	100%	<i>tus</i>	50%
<i>Eustachys mutica</i>	75%	<i>Themeda triandra</i> ...	50%
<i>Elionurus muticus</i>	75%	<i>Eragrostis curvula</i> ...	50%
<i>Pavonia burchellii</i>	50%	<i>Kalanchoe panicula-</i>	
<i>Hyparrhenia hirta</i>	50%	<i>lata</i>	50%

1.3.3 *Euclea crispa*—*Buddleja saligna*—*Acacia caffra* Bush

These communities are mostly found on steep, rocky slopes (more than 22°), at an altitude of 1 660–1 770 m. The dense vegetation ranges from Fosberg's (1967) deciduous thorn savanna (112/3) to microphyllous deciduous thorn scrub savanna (1K2/5), and is characterized by the *Buddleja saligna* species group (Table 2).

Two variations are recognized:

(a) *Acacia caffra*—*Aloe marlothii* Variant (Figs 5 & 6)

This variation is situated on steep, rocky north-, northwest- and northeast-facing slopes, where more

than 60% of the soil surface is covered by large rocks. The *Aloe marlothii* species group (Table 2) is characteristic of this variant. The total canopy cover is 60–95% and an average of 25 species was recorded per relevé.

The trees of this variation are up to 10 m tall and the canopy cover of the tree stratum is 30–80%. The most conspicuous trees are *Aloe marlothii* (87%), *Acacia caffra* (80%), *Rhus leptodictya* (93%), *Tarchonanthus camphoratus* (53%) and *Buddleja saligna* (53%) (Table 3). Other trees include *Dombeya rotundifolia* (73%), *Euclea crispa* (73%), *Fagara capensis* (67%), *Canthium gilfillanii* (53%), *Acacia karroo* (47%), *Ziziphus mucronata* (47%) and *Celtis africana* (47%).

The canopy cover of the shrub stratum is 10–50%. *Maytenus polyacantha* (87%), *Aloe marlothii* (87%) and *Isoglossa grantii* (80%) are the most prominent shrubs in this community (Table 3). The large patches of *Maytenus polyacantha* forming impenetrable bush

FIG. 5.—Dense *Acacia caffra*—*Aloe marlothii* Bush on steep north-facing slopes (a); *Acacia karroo*—*Teucrium capense* Savanna in the valley (b); and *Berkheya setifera*—*Koeleria cristata*—*Pentanisia prunelloides* Grassland on the south-facing slopes (c).



FIG. 6.—*Acacia caffra*—*Aloe marlothii* Bush.



thickets are a conspicuous feature of this vegetation. Other shrubs include the following:

<i>Euclea crispa</i>	73%	<i>Canthium gilfillanii</i>	53%
<i>Felicia filifolia</i>	73%	<i>Asparagus suaveo-</i>	
<i>Dombeya rotundifo-</i>		<i>lens</i>	53%
<i>lia</i>	73%	<i>Ehretia rigida</i>	47%
<i>Lippia javanica</i>	60%	<i>Opuntia sp.</i>	40%
<i>Tarchonanthus cam-</i>		<i>Diospyros lycioides</i>	40%
<i>phoratus</i>	53%		

The lianes *Rhoicissus tridentata* (93%) and *Dioscorea sylvatica* (47%) are often found in the tree and shrub strata.

The herbaceous layer varies considerably as a result of the local variation in the canopy cover of the tree and shrub strata. The canopy cover of the herbaceous layer is as low as 5% under the denser woody layer, but may be up to 50% where the upper layers are more open. Herbaceous plants often present in this community include:

<i>Eragrostis curvula</i> ...	80%	<i>Pellaea calomelanos</i>	47%
<i>Eustachys mutica</i>	73%	<i>Ledebouria sp.</i>	40%
<i>Aristida junciformis</i> ..	67%	<i>Sida dregei</i>	33%
<i>Commelina africana</i> ..	67%	<i>Ruellia cordata</i>	27%
<i>Themeda triandra</i>	60%	<i>Aloe davyana</i>	27%
<i>Kalanchoe paniculata</i>	53%		

(b) *Euclea crispa*—*Buddleja saligna* Variant

This variation is situated on rocky south- and east-facing slopes with large rocks covering 21–60% of the soil surface. The variation is distinguished from the *Acacia caffra*—*Aloe marlothii* Bush by the absence of the *Aloe marlothii* species group as well as the absence of *Acacia karroo* (Table 2). An average of 27 species per relevé was recorded and the total canopy cover varies from 70 to 80%.

The tree stratum is up to 8 m tall and has a canopy cover of 50–70%. The most prominent species include *Buddleja saligna* (86%), *Euclea crispa* (86%), *Rhus leptodictya* (86%), *Canthium gilfillanii* (71%), *Acacia caffra* (57%) and *Heteromorpha arborescens* (43%) (Table 3). Other trees include *Fagara capensis* (71%), *Ziziphus mucronata* (57%), *Celtis africana* (57%), *Olea africana* (43%), *Cussonia paniculata* (43%) and *Rhus pyroides* (29%).

The shrub stratum has a 20–50% canopy cover and is mainly composed of the following species:

<i>Felicia filifolia</i>	86%	<i>Fagara capensis</i>	71%
<i>Euclea crispa</i>	86%	<i>Maytenus polyacan-</i>	
<i>Grewia occidentalis</i> ...	86%	<i>tha</i>	57%
<i>Asparagus suaveolens</i>	71%	<i>Diospyros whyteana</i>	57%
<i>Canthium gilfillanii</i> ...	71%	<i>Myrsine africana</i> ...	57%
<i>Diospyros lycioides</i> ..	71%	<i>Ehretia rigida</i>	29%
<i>Isoglossa grantii</i>	71%		

Lianes found in the woody strata include *Rhoicissus tridentata* (100%), *Asparagus aethiopicus* (57%) and *Dioscorea sylvatica* (29%).

The herbaceous layer is normally poorly represented, but *Themeda triandra* (71%), *Eustachys mutica* (57%) and *Eragrostis curvula* (43%) are fairly abundant locally (Table 3). Other herbs include *Commelina africana* (71%), *Ledebouria sp.* (71%), *Kalanchoe paniculata* (57%), *Aloe davyana* (57%), *Sida dregei* (57%) and *Pellaea calomelanos* (43%).

1.4 *Acacia caffra*—*Teucrium capense* Savanna

This community occurs on rocky south- and west-facing slopes of the Holhoek Kloof. The vegetation varies from the microphyllous deciduous thorn shrub savanna (1K2/5) to the evergreen broad sclerophyll forest (1A1/6) of Fosberg (1967). The

combination of *Acacia caffra*, *Rhus pyroides*, *Teucrium capense*, *Cynodon dactylon*, *Ehrharta erecta* and *Tarchonanthus camphoratus* is characteristic of this community (Table 2). The total canopy cover of the vegetation is 60–90% and an average of 28 species was recorded per relevé.

In the open areas the trees are up to 6 m tall, with a canopy cover of 50–60%, but in denser areas the canopy cover may be as high as 80% and the trees are up to 12 m tall. The most prominent trees include *Acacia caffra* (100%), *Rhus pyroides* (75%), *Euclea crispa* (75%), *Celtis africana* (75%), *Ziziphus mucronata* (75%), *Tarchonanthus camphoratus* (75%) and *Maytenus heterophylla* (75%) (Table 3).

The shrub stratum covers 10–30% and the most prominent shrubs include *Maytenus heterophylla* (75%) and *Felicia filifolia* (75%) (Table 3). Other shrubs which may be present are *Diospyros lycioides* (75%), *Asparagus suaveolens* (75%), *Lippia javanica* (75%), *Isoglossa grantii* (50%) and *Ehretia rigida* (50%).

The canopy cover of the herbaceous layer is only 15–40%, but the layer may be up to 1 m tall owing to tall *Cymbopogon validus* (75%) and *C. marginatus* (50%). *Eragrostis curvula* (25%) is locally prominent (Table 3). Other herbs often found in this community include *Achyranthes aspera* (100%), *Ledebouria sp.* (100%), *Ehrharta erecta* (75%), *Aristida congesta* (75%), *Solanum rigiscens* (75%), *Pellaea calomelanos* (50%) and *Pavonia burchellii* (50%).

1.5 *Acacia karroo*—*Teucrium capense* Savanna Communities (Fig. 5)

These open Savanna Communities occur at relatively low altitudes, on clay loam soils, in sheltered valleys and often along dry stream banks. These communities are characterized by the *Acacia karroo* species group (Table 2). *Acacia karroo* is by far the most prominent species in this community, which corresponds to the deciduous microphyll thorn savanna of Fosberg (1967). Three variations are distinguished and described under 1.5.1, 1.5.2 and 1.5.3.

1.5.1 *Acacia karroo*—*Teucrium capense*—*Conyza podocephala* Savanna

This variation is situated on fairly rocky northeast-, south- and southwest-facing slopes of less than 9°, usually at the foot of adjacent rocky hills. The *Conyza podocephala* species group (Table 2) is characteristic of this variation. An average of 30 species was recorded per relevé and the total canopy cover of the vegetation is 60–80%.

The tree stratum is up to 6 m tall with 20–40% canopy cover. *Acacia karroo* (100%) is the most prominent tree (Table 3). *Rhus pyroides* (50%), *Euclea crispa* (50%), *Celtis africana* (50%) and *Ziziphus mucronata* (50%) are locally present (Table 2).

The shrub stratum has a 5–20% canopy cover and is composed of *Acacia karroo* (100%), *Diospyros lycioides* (100%), *Asparagus suaveolens* (100%), *Lippia javanica* (75%), *Euclea crispa* (50%), *Felicia filifolia* (50%) and *Lantana rugosa* (50%).

The herbaceous layer is well developed with 50–70% canopy cover. *Eragrostis curvula* (100%) is often the most conspicuous species in the herbaceous layer (Table 3), but *Themeda triandra* (75%), *Hyparrhenia*

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hirta (75%) and *Teucrium capense* (100%) are locally abundant. Other species include:

<i>Conyza podocephala</i> 100%	<i>Pollichia campestris</i> 50%
<i>Hermannia depressa</i> 100%	<i>Osteospermum muricatum</i> 50%
<i>Helichrysum rugulosum</i> 75%	<i>Helichrysum nudifolium</i> 50%
<i>Crabbea acaulis</i> 75%	<i>Eragrostis chlorome-las</i> 50%
<i>Solanum incanum</i> 75%	<i>E. racemosa</i> 50%
<i>Heteropogon contortus</i> 50%	<i>Setaria sp.</i> 50%
<i>Elionurus muticus</i> * 50%	

1.5.2 *Acacia karroo*—*Teucrium capense*—*Felicia muricata* Savanna

This variation is usually situated on flat, rockless areas on black clay soils, and is characterized by the *Albucca setosa* species group (Table 2). The area was previously overgrazed and trampled. Surface erosion occurs on large areas while more severe donga erosion is found locally. An average of 23 species was recorded per relevé and the vegetation has a total canopy cover of 60–80%.

The tree stratum is up to 8 m tall with a canopy cover of 20–60%. This stratum is mostly fairly open, but denser thickets appear locally. *Acacia karroo* (100%) is the most prominent species (Table 3) but *Ziziphus mucronata* (57%), *Euclea crispa* (28%) and *Rhus pyroides* (28%) are also present in this variation.

The open shrub stratum has a canopy cover of 10–20% and consists mostly of younger individuals of *Acacia karroo* (100%).

Local bush encroachment of *Acacia karroo* may become a serious problem as a result. Other shrubs present in this variation include *Asparagus suaveolens* (100%), *Pavonia burchellii* (100%), *Isoglossa grantii* (86%), *Lantana rugosa* (71%), *Felicia filifolia* (57%), *Maytenus polyacantha* (43%), *Lippia javanica* (43%) and *Grewia occidentalis* (29%).

The herbaceous layer is often up to 0.8 m tall and is often well developed with a canopy cover of up to 70%. *Eragrostis curvula* (100%) and *Themeda triandra* (71%) are conspicuous (Table 3). However, many bare patches are present in this community where the herbaceous layer has a canopy cover of only 20%. The pioneer species *Felicia muricata* (86%), *Aristida congesta* (86%), *Cynodon dactylon* (71%), *Aristida junciformis* (43%) and *Conyza podocephala* (29%) are conspicuous here. Other herbs include (Table 2):

<i>Teucrium capense</i> 100%	<i>Achyranthes aspera</i> 43%
<i>Albucca setosa</i> 100%	<i>Commelina africana</i> 43%
<i>Delosperma mahonii</i> 71%	<i>Kalanchoe rotundifolia</i> 29%
<i>Bulbine narcissifolia</i> 57%	<i>K. paniculata</i> 29%
<i>Talinum caffrum</i> 57%	<i>Hypoxis rooperi</i> 29%
<i>Setaria flabellata</i> 57%	<i>Antizoma sp.</i> 29%
<i>Sida dregei</i> 57%	

1.5.3 *Acacia karroo*—*Acacia caffra*—*Teucrium capense* Savanna

This variation is found on rocky slopes of 8–17° on the hills adjacent to the *Acacia karroo*—*Teucrium capense*—*Felicia muricata* Savanna. This community is differentiated from the other variations of the *Acacia karroo*—*Teucrium capense* Savanna by the absence of the *Conyza podocephala* and *Albucca setosa* species groups (Table 2). An average of 22 species was recorded per relevé and the total canopy cover of the vegetation is 60–70%.

The tree stratum is up to 6 m tall and has a canopy cover of 20–60%. *Acacia karroo* (80%) is the most prominent species in this fairly open savanna, but

local bush encroachment of *A. karroo* results in dense bush thickets. *A. caffra* (40%) is locally also prominent (Table 3) and other trees present include *Ziziphus mucronata* (60%), *Celtis africana* (60%) and *Euclea crispa* (40%).

The shrub stratum is usually fairly open, with 10–20% canopy cover, and is dominated by *Acacia karroo* (80%). *Asparagus suaveolens* (80%) is also conspicuous in this stratum (Table 3). Other shrubs include *Lippia javanica* (80%), *Diospyros lycioides* (60%), *Felicia filifolia* (60%), *Isoglossa grantii* (40%), *Maytenus polycantha* (40%) and *Ruellia cordata* (40%).

Rhoicissus tridentata (60%) is often found scrambling in the tree and shrub strata.

The herbaceous layer has a canopy cover of 40–60%, and is often up to 1 m tall. *Eustachys mutica* (40%) and *Cynodon dactylon* (80%) are often prominent (Table 3). The high canopy cover of the hardy pioneer species *Aristida congesta* (100%), *Cynodon dactylon* (80%), *Sida dregei* (60%), *Eragrostis pseudosclerantha* (60%) and *Aristida junciformis* (40%) is an indication of previous mismanagement of this vegetation. Other herbs include the following:

<i>Eragrostis curvula</i> 100%	<i>Pavonia burchellii</i> 60%
<i>Themeda triandra</i> 60%	<i>Delosperma mahonii</i> 40%
<i>Elionurus muticus</i> 60%	<i>Aloe davyana</i> 40%
<i>Teucrium capense</i> 60%	<i>Eragrostis chlorome-las</i> 40%
<i>Achyranthes aspera</i> 60%	

2. *Trachypogon spicatus*—*Themeda triandra* Grassland Communities

The communities of this grassland are summarized in Table 4. These communities cover the high altitude plateaux and low altitude flats, but also occur on gentle rockless slopes. This grassveld is characterized by the *Trachypogon spicatus* species group (Table 4) often with *Trachypogon spicatus*, *Themeda triandra* and *Heteropogon contortus* as the most prominent species. Three major communities are distinguished and are described under 2.1, 2.2 and 2.3.

2.1 *Rhynchelytrum setifolium*—*Monocymbium cereisiforme* Grassland

This community occurs on very shallow soils on the rocky outcrops sporadically distributed at altitudes of 1 830–1 870 m, on the mountain plateaux. Large rocks cover more than 80% of the soil surface and the soil and vegetation are restricted to small patches between the rocks. The canopy cover of the vegetation is often less than 50% and the vegetation corresponds to Fosberg's (1967) seasonal orthophyll short grass (IM2/1). An average of 23 species was recorded per relevé.

This community is characterized by the *Monocymbium cereisiforme* species group (Table 4), while the presence of the *Rhynchelytrum setifolium* species group, which is also present in the *Berkheya setifera*—*Rhynchelytrum setifolium* Grassland, is also an important feature of this community. Another important characteristic of this community is its negative association with the *Acalypha punctata* species group, which occurs in all the other *Trachypogon spicatus*—*Themeda triandra* Grassland communities represented in the study area.

A scanty shrub stratum is represented by a few dwarfed shrubs. The only woody species which is fairly constantly present is *Rhus eckloniana* (86%). Small individuals of *Euclea crispa*, *Maytenus heterophylla*, *Myrsine africana*, *Diospyros lycioides* and *Rhoicissus tridentata* are locally present.

* *Elionurus muticus* (= *E. argenteus*)

TABLE 5.—Prominent species in the *Trachypogon spicatus*—*Themeda triandra* Grassland Communities

Plant species	Community number							
	2.1	2.2.1	2.2.2	2.2.3	2.2.4	2.3.1	2.3.2	2.3.3
<i>Cymbopogon marginatus</i>	P							
<i>Rhynchelytrum setifolium</i>	P	P			P			
<i>Berkheya setifera</i>			P					
<i>Hyparrhenia hirta</i>				P				
<i>Rhus discolor</i>					p			
<i>Digitaria diagonalis</i>					p			
<i>Elionurus muticus</i>						p	p	p
<i>Eragrostis chloromelas</i>						p	p	
<i>Eragrostis racemosa</i>						p		p
<i>Eragrostis curvula</i>						p		p
<i>Themeda triandra</i>	p	P	P	P	P		P	P
<i>Trachypogon spicatus</i>			P	P	P	P		P
<i>Heteropogon contortus</i>		P			P	P		P

Explanation of "P" and "p" in text.

The herbaceous layer is dominated by *Rhynchelytrum setifolium* (100%) and *Cymbopogon marginatus* (100%), but *Themeda triandra* (86%) is often locally abundant (Table 5). Other species include the following:

<i>Monocymbium cere-</i> <i>siiforme</i>	100%	<i>Diheteropogon am-</i> <i>plectens</i>	57%
<i>Pellaea calomelanos</i> ..	100%	<i>Cheilanthes hirta</i>	57%
<i>Crassula setulosa</i>	86%	<i>Oldenlandia herba-</i> <i>cea</i>	43%
<i>Sutera caerulea</i>	86%	<i>Pelargonium luridum</i>	43%
<i>Streptocarpus vande-</i> <i>leurii</i>	86%	<i>Trachypogon spica-</i> <i>tus</i>	43%
<i>Ursinea nana</i> subsp.		<i>Eragrostis racemosa</i>	43%
<i>leptophylla</i>	86%	<i>Ipomoea ommaneyi</i> ..	4%
<i>Senecio oxyriifolia</i> ...	86%	<i>Microchloa caffra</i> ...	43%
<i>Leonotis microphyll-</i> <i>um</i>	71%	<i>Raphionacme hirsu-</i> <i>ta</i>	43%
<i>Selaginella dregei</i>	71%		

2.2 *Themeda triandra*—*Berkheya setifera*—*Rhus discolor* Grassland Communities

These grassland communities are situated on the plateaux (Fig. 7) and adjacent slopes, and are characterized by the *Berkheya setifera* species group. Other

important features of these communities are the presence of the *Vernonia natalensis* species group and the high canopy cover and constancy of many species of the family Asteraceae (Table 4). The vegetation corresponds to a seasonal orthophyll tall grass (1L2/1) of Fosberg (1967). Four different communities are distinguished and described under 2.2.1, 2.2.2, 2.2.3 and 2.2.4.

2.2.1 *Berkheya setifera*—*Rhynchelytrum setifolium* Grassland

This community is usually found on the fairly rocky patches, scattered on the plateaux. Rocks cover 20–60% of the soil surface and the soils are seldom deeper than 300 mm. The vegetation is up to 1 m tall, and usually very dense; canopy cover is often as high as 95%. An average of 32 species was recorded per relevé.

The *Vernonia galpinii* species group (Table 4) characterizes this community, and the *Rhynchelytrum setifolium* species group, also characteristic of the *Rhynchelytrum setifolium*—*Monocymbium ceresiiforme*



FIG. 7.—*Themeda triandra*—*Berkheya setifera*—*Rhus discolor* Grassland on the undulating plateaux.

Grassveld on the rocky outcrops, is likewise an important feature of this community.

Low-growing shrubby plants such as *Rhus eckloniana* (53%), *Athrixia elata* (47%), *Chrysanthemoides monilifera* (47%) and *Elephantorrhiza elephantina* (20%) are found scattered in this community, but they are inconspicuous, because they are dwarfed by the dense, tall-growing herbaceous layer.

Themeda triandra (80%) is often the most prominent species. *Rhynchelytrum setifolium* (93%), *Berkheya setifera* (80%) and *Heteropogon contortus* (47%) are also conspicuous (Table 5), while *Eragrostis racemosa* (80%), *Tristachya hispida* (60%) and *Rhus discolor* (53%) are locally abundant. Other species include the following:

<i>Brachiaria serrata</i> ...	100%	<i>Ipomoea crassipes</i> ...	33%
<i>Acalypha punctata</i> ...	73%	<i>Bulbostylis burchellii</i> ...	33%
<i>Cymbopogon marginatus</i> ...	73%	<i>Lotononis foliosa</i> ...	33%
<i>Vernonia galpinii</i> ...	60%	<i>Diheteropogon amplexans</i> ...	33%
<i>V. natalensis</i> ...	60%	<i>Aloe davyana</i> ...	33%
<i>Pentania angustifolia</i>	60%	<i>Pelargonium luridum</i>	27%
<i>Senecio coronatus</i> ...	60%	<i>Helichrysum nudifolium</i> ...	27%
<i>Kohautia amatymbica</i>	60%	<i>Ledebouria marginata</i> ...	27%
<i>Anthospermum rigidum</i> ...	60%	<i>Cyanotis speciosa</i> ...	27%
<i>Trachypogon spicatus</i>	60%	<i>Eragrostis curvula</i> ...	20%
<i>Lotononis calycina</i> ...	53%	<i>Setaria nigrirostris</i> ...	20%
<i>Monsonia attenuata</i> ...	47%	<i>Silene burchellii</i> ...	20%
<i>Bewsia biflora</i> ...	47%	<i>Microchloa caffra</i> ...	20%
<i>Tephrosia capensis</i> ...	47%	<i>Andropogon schirensis</i> ...	20%
<i>Eragrostis capensis</i> ...	47%	<i>Pleiospora cajanifolia</i> ...	20%
<i>Rhynchosia totta</i> ...	47%	<i>Cussonia paniculata</i>	20%
<i>Becium obovatum</i> ...	40%	<i>Aster harveyanus</i> ...	20%
<i>Hypoxis rigidula</i> ...	40%	<i>Turbina oblongata</i> ...	20%
<i>Crabbea acaulis</i> ...	40%	<i>Gnidia capitata</i> ...	20%
<i>Ajuga ophrydis</i> ...	40%		
<i>Chaetacanthus burchellii</i> ...	40%		
<i>Helichrysum adscendens</i> ...	33%		

2.2.2 *Berkheya setifera*—*Koeleria cristata*—*Pentania prunelloides* Grassland (Fig. 5)

This very dense grassland occurs on south-facing slopes that are mostly steeper than 10° and usually occur at altitudes of more than 1 700 m. Large rocks are locally present, but never prominent. The community is characterized by the *Koeleria cristata*

species group (Table 4). The vegetation is up to 1 m tall with 60–95% canopy cover. A few scattered individual shrublets of *Rhus pyroides*, *Artemisia afra*, *Cussonia paniculata*, *Athrixia elata* and *Psoralea polysticta* are dwarfed by the very dense herbaceous layer.

The grasses *Themeda triandra* (87%) and *Trachypogon spicatus* (87%) are very prominent (Table 5) and cover large areas. *Berkheya setifera* (73%), *Vernonia natalensis* (73%) and *Rhus discolor* (93%) are locally conspicuous. *Harporchloa falx* (53%), *Aster peglerae* (33%), *Digitaria diagonalis* (47%), *Setaria nigrirostris* (33%) and *Helictotrichon turgidulum* (33%) are less constantly present, but are locally abundant. Other species present include:

<i>Acalypha punctata</i> ...	93%	<i>Tristachya hispida</i> ...	47%
<i>Koeleria cristata</i> ...	87%	<i>Cymbopogon excavatus</i> ...	57%
<i>Brachiaria serrata</i> ...	89%	<i>Hibiscus aethiopicus</i>	
<i>Pentania prunelloides</i> ...	67%	var. <i>ovatus</i> ...	47%
<i>Kohautia amatymbica</i>	67%	<i>Hypoxis rigidula</i> ...	40%
<i>Schistostephium crataegifolium</i> ...	60%	<i>Tephrosia capensis</i> ...	40%
<i>Crabbea acaulis</i> ...	60%	<i>Heteropogon contortus</i> ...	40%
<i>Senecio inornatus</i> ...	60%	<i>Silene burchellii</i> ...	40%
<i>Becium obovatum</i> ...	53%	<i>Senecio isatideus</i> ...	40%
<i>Indigofera zeyheri</i> ...	53%		
<i>Helichrysum micanaefolium</i> ...	53%		

2.2.3 *Berkheya setifera*—*Hyparrhenia hirta* Grassland

This community occurs at altitudes of 1 740–1 870 m on moderate to steep (3°–16°) north-, east- and west-facing slopes (Fig. 8). The vegetation is up to 1.5 m tall and has a canopy cover of 90–95%. An average of 26 species was recorded per relevé.

Individual shrubs of *Rhus eckloniana*, *Athrixia elata*, *Lippia javanica*, *Elephantorrhiza elephantina* and *Ziziphus zeyherana* are found scattered in the dense herbaceous layer.

The constant high canopy cover of *Hyparrhenia hirta* (100%) (Table 4) is characteristic for this community. Other prominent species are *Trachypogon spicatus* (100%) and *Themeda triandra* (58%).



FIG. 8.—*Berkheya setifera*—*Hyparrhenia hirta* Grassland on moderate north-facing slopes.

Other species present include the following:

<i>Acalypha punctata</i> ...	84%	<i>Indigofera zeyheri</i> ...	53%
<i>Berkheya setifera</i> ...	79%	<i>Pentanisia angustifolia</i> ...	53%
<i>Brachiaria serrata</i> ...	79%	<i>Tristachya hispida</i> ...	47%
<i>Crabbea acaulis</i> ...	74%	<i>Tephrosia capensis</i> ...	47%
<i>Senecio coronatus</i> ...	74%	<i>Eragrostis racemosa</i> ...	47%
<i>Diheteropogon amplexifolius</i> ...	63%	<i>E. capensis</i> ...	42%
<i>Cymbopogon excavatus</i> ...	63%	<i>Hermannia depressa</i> ...	42%
<i>Setaria nigrirostris</i> ...	63%	<i>Helichrysum miconeaefolium</i> ...	42%
<i>Rhus discolor</i> ...	58%	<i>Bulbostylis burchellii</i> ...	42%
<i>Vernonia natalensis</i> ...	58%	<i>Lotononis calycina</i> ...	36%
<i>Becium obovatum</i> ...	58%	<i>Senecio affinis</i> ...	36%
<i>Heteropogon contortus</i> ...	53%	<i>Aloe davyana</i> ...	36%
<i>Kohautia amatymbica</i>	53%	<i>Ipomoea crassipes</i> ...	36%

2.2.4 *Berkheya setifera*—*Digitaria diagonalis* Grassland

This community is restricted to the less rocky areas of the plateaux, at altitudes of 1 780–1 870 m. Large single rocks occur sparsely in this community.

The presence of the *Berkheya setifera* species group combined with the absence of the *Rhynchelytrum setifolium*, *Vernonia galpinii*, *Koeleria cristata* and *Hyparrhenia hirta* species groups (Table 4) is characteristic of this community. The vegetation is 1 m tall and has a canopy cover of 80–95%. An average of 26 species was recorded per relevé.

Themeda triandra (100%) and *Trachypogon spicatus* (75%) are the most prominent species, but *Berkheya setifera* (100%), *Rhus discolor* (88%), *Digitaria diagonalis* (63%) and *Heteropogon contortus* (75%) are locally conspicuous (Table 5).

Other species include the following:

<i>Acalypha punctata</i> ...	100%	<i>Setaria nigrirostris</i> ...	38%
<i>Brachiaria serrata</i> ...	88%	<i>Ipomoea crassipes</i> ...	38%
<i>Eragrostis racemosa</i> ...	75%	<i>Andropogon schirensis</i> ...	38%
<i>Kohautia amatymbica</i>	75%	<i>Eulophia clavicornis</i>	38%
<i>Senecio coronatus</i> ...	75%	<i>Helictotrichon turgidulum</i> ...	25%
<i>Diheteropogon amplexifolius</i> ...	63%	<i>Elionurus muticus</i> ...	25%
<i>Helichrysum miconeaefolium</i> ...	63%	<i>Senecio asperulus</i> ...	25%
<i>Vernonia natalensis</i> ...	63%	<i>Indigofera zeyheri</i> ...	25%
<i>Tristachya hispida</i> ...	63%	<i>Lotononis foliosa</i> ...	25%
<i>Becium obovatum</i> ...	50%	<i>Senecio inornatus</i> ...	25%
<i>Pentanisia angustifolia</i> ...	50%	<i>Indigofera hilaris</i> ...	25%
<i>Cymbopogon excavatus</i> ...	50%	<i>Chaetacanthus burchellii</i> ...	25%
<i>Lotononis calycina</i> ...	50%	<i>Ledebouria marginata</i> ...	25%
<i>Crabbea acaulis</i> ...	50%	<i>Cyanotis speciosa</i> ...	25%
<i>Monsonia attenuata</i>	38%	<i>Gerbera viridifolia</i>	25%
<i>Senecio affinis</i> ...	38%	<i>Turbina oblongata</i>	25%
<i>Ajuga ophrydis</i> ...	38%	<i>Helichrysum adscendens</i> ...	25%
<i>Eragrostis curvula</i> ...	38%		

2.3 *Elionurus muticus*—*Themeda triandra* Grassland Communities

These grassland communities occur on the relatively low altitude flats and on the undulating hills at the foot of the mountains, and also in the lower parts of the mountain slopes. They are characterized by the *Elionurus muticus* species group (Table 4). Most parts correspond to seasonal orthophyll tall grass (1L2/1), but several patches appear to be seasonal orthophyll short grass (1M2/1) of Fosberg (1967). Three communities are distinguished and described under 2.3.1, 2.3.2 and 2.3.3.

2.3.1 *Elionurus muticus*—*Themeda triandra*—*Trachypogon spicatus* Grassland

This community occurs at altitudes of 1 600–1 750 m, on the lower parts of the mountain slopes, and clearly represents a transition between the

Themeda triandra—*Berkheya setifera*—*Rhus discolor* Grassland Communities of the higher altitudes and the remainder of the *Elionurus muticus*—*Themeda triandra* Grassland Communities of the relatively low altitudes. This is illustrated by the combination of the *Elionurus muticus* species group typical of the low altitude communities, with the *Vernonia natalensis* species group, typical of the high altitude communities (see Table 4). The vegetation is up to 0.5 m tall with 60–95% canopy cover. An average of 32 species was recorded per relevé.

The shrubs *Diospyros lycioides*, *Cussonia paniculata*, *Maytenus heterophylla*, *Leucosidea sericea*, *Cassine aethiopica*, *Euclea crispa* and *Rhoicissus tridentata* occur on rocky outcrops scattered throughout the community.

The most prominent grasses in this community are *Trachypogon spicatus* (94%), *Elionurus muticus* (94%), *Heteropogon contortus* (82%), *Eragrostis racemosa* (88%) and *Eragrostis chloromelas* (41%) (Table 5).

Other species present include:

<i>Tephrosia capensis</i> ...	94%	<i>Thesium transvaalense</i> ...	47%
<i>Acalypha punctata</i> ...	88%	<i>Hyparrhenia hirta</i> ...	41%
<i>Brachiaria serrata</i> ...	82%	<i>Indigofera zeyheri</i> ...	41%
<i>Hermannia depressa</i>	70%	<i>Helichrysum nudifolium</i> ...	41%
<i>Crabbea acaulis</i> ...	65%	<i>Ajuga ophrydis</i> ...	41%
<i>Helichrysum rugulosum</i> ...	59%	<i>Aloe davyana</i> ...	41%
<i>Nidorella anomala</i> ...	59%	<i>Chaetacanthus burchellii</i> ...	41%
<i>Pentanisia angustifolia</i> ...	59%	<i>Vernonia oligocephala</i> ...	35%
<i>Themeda triandra</i> ...	53%	<i>Sida dregei</i> ...	35%
<i>Vernonia natalensis</i> ...	53%	<i>Becium obovatum</i> ...	35%
<i>Kohautia amatymbica</i>	53%	<i>Hypoxis rigidula</i> ...	35%
<i>Anthospermum rigidum</i> ...	53%	<i>Helichrysum miconeaefolium</i> ...	35%
<i>Tristachya hispida</i> ...	47%	<i>Carex spicata-paniculata</i> ...	35%
<i>Cymbopogon excavatus</i> ...	47%	<i>Senecio inornatus</i> ...	35%
<i>Bulbostylis burchellii</i>	47%	<i>Rhynchosia totta</i> ...	35%
<i>Phyllanthus parvulus</i>	47%		
<i>Eragrostis capensis</i> ...	47%		
<i>Setaria nigrirostris</i> ...	47%		
<i>Hibiscus aethiopicus</i> var. <i>ovatus</i> ...	47%		

2.3.2 *Elionurus muticus*—*Themeda triandra*—*Teucrium capense* Grassland

This grassland occurs on the relatively low altitude (1 580–1 660 m) flats at the foot of the mountains, and is usually situated adjacent to the *Acacia karroo*—*Teucrium capense* Savanna Communities (1.5 above). It probably represents a transition between these Savanna Communities and the *Elionurus muticus*—*Themeda triandra*—*Eragrostis curvula* Grassland (2.3.3 below).

The *Elionurus muticus*—*Themeda triandra*—*Teucrium capense* Grassland is characterized by the *Senecio asperulus* species group (Table 4). The total canopy cover of the vegetation is 60–95%. An average of 21 species was recorded per relevé.

A conspicuous feature of this community is the absence or low constancy of *Trachypogon spicatus*, *Acalypha punctata*, *Brachiaria serrata*, *Diheteropogon amplexifolius*, *Aloe davyana*, *Ajuga ophrydis* and *Eragrostis capensis*, which are all constantly present in the other *Trachypogon spicatus*—*Themeda triandra* Grassland Communities. The presence of pioneer species such as *Helichrysum rugulosum* (88%), *Senecio asperulus* (75%), *Hermannia depressa* (75%), *Anthospermum rigidum* (75%), *Felicia muricata* (50%) and *Conyza podocephala* (38%), as well as the local surface erosion present in this community, suggest that this vegetation has resulted from previous mismanagement.



FIG. 9.—Donga erosion in *Elionurus muticus*—*Themeda triandra*—*Eragrostis curvula* Grassland.

Shrubs that occur scattered in this community include the following: *Acacia karroo*, *Diospyros lycioides*, *Ziziphus mucronata*, *Ehretia rigida*, *Canthium gilfillanii*, *Euclea crispa*, *Asparagus suaveolens*, *Grewia occidentalis*, *Rhus leptodictya* and *Rhoicissus tridentata*.

The herbaceous layer is up to 1 m tall with *Themeda triandra* (100%) the most conspicuous species. *Eragrostis chloromelas* (63%) and *Elionurus muticus* (100%) are locally very abundant (Table 5).

Other species present include the following:

<i>Sida dregei</i>	88%	<i>Ledebouria ovatifolia</i>	38%
<i>Setaria flabellata</i>	75%	<i>Rhynchosia totta</i>	25%
<i>Teucrium capense</i>	75%	<i>Hibiscus aethiopicus</i>	
<i>Bulbine abyssinica</i>	75%	var. <i>ovatus</i>	25%
<i>Crabbea acaulis</i>	75%	<i>Microchloa caffra</i> ...	25%
<i>Lippia javanica</i>	63%	<i>Solanum incanum</i> ...	25%
<i>Heteropogon contortus</i>	63%	<i>Striga elegans</i>	25%
<i>Eragrostis racemosa</i> ...	50%	<i>Aristida dasylesmis</i> ...	25%
<i>Hyparrhenia hirta</i>	38%	<i>A. junciformis</i>	25%
<i>Tephrosia capensis</i> ...	38%	<i>Arctotis arctotoides</i> ...	25%
<i>Trachypogon spicatus</i>	38%	<i>Albucca setosa</i>	25%
<i>Thesium transvaalense</i>	38%		

<i>Crabbea acaulis</i>	79%	<i>Anthericum fasciculatum</i>	29%
<i>Acalypha punctata</i> ...	79%	<i>Sida dregei</i>	21%
<i>Hyparrhenia hirta</i> ...	79%	<i>Ipomoea crassipes</i> ..	21%
<i>Brachiaria serrata</i> ...	64%	<i>Pachycarpus schinzianus</i>	21%
<i>Eragrostis capensis</i> ...	57%	<i>Senecio othonniiflorus</i>	21%
<i>Senecio inornatus</i> ...	50%	<i>Ledebouria ovatifolia</i>	21%
<i>Eragrostis chloromelas</i>	43%	<i>Asclepias stellifera</i> ..	21%
<i>Setaria flabellata</i>	43%	<i>Hypericum aethiopicum</i> subsp. <i>sonderi</i>	21%
<i>Ajuga ophrydis</i>	43%	<i>Ziziphus zeyherana</i>	21%
<i>Indigofera hilaris</i>	43%		
<i>Aloe davyana</i>	43%		
<i>Thesium transvaalense</i>	43%		
<i>Microchloa caffra</i>	36%		
<i>Nidorella anomala</i>	29%		

DISCUSSION

As was pointed out by Coetzee (1974) and Bredenkamp & Theron (1976; 1978), the polythetic nature of the Braun-Blanquet method provides a very natural classification of vegetation, where plant communities are closely related to a specific set of environmental conditions. This is again emphasized in the present study.

Habitat conditions strongly associated with differences in vegetation include altitude, aspect, slope, rockiness of the soil surface, soil depth and soil texture.

Closely related communities are grouped into larger units, which may be of great practical value in a management programme.

Although the communities are arranged into a hierarchical system, the data obtained in this study are not sufficient to determine character species or to ensure correct ranking of the syntaxa represented in the Bankenveld (Acocks, 1975).

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2.3.3 *Elionurus muticus*—*Themeda triandra*—*Eragrostis curvula* Grassland

This grassland occurs on the undulating hills and flats at the foot of the mountains, at altitudes of 1 640–1 800 m. Surface erosion and more severe donga erosion occur locally in this community (Fig. 9). The presence of the *Elionurus muticus* species group together with the absence of the *Senecio asperulus* and *Vernonia natalensis* species groups is characteristic for this community (Table 4). The most prominent species include *Themeda triandra* (93%), *Eragrostis curvula* (86%), *Elionurus muticus* (86%), *Eragrostis racemosa* (79%), *Heteropogon contortus* (79%) and *Trachypogon spicatus* (64%).

Other species present in this community include the following:

<i>Hermannia depressa</i>	93%	<i>Chaetacanthus burchellii</i>	29%
<i>Anthospermum rigidum</i>	79%	<i>Andropogon appendiculatus</i>	29%
<i>Tephrosia capensis</i> ...	79%		

UITTREKSEL

Die plantegroei van die Sisteem Ventersdorp van die Suikerbosrandnatuurreservaat is volgens die Braun-Blanquet-metode bestudeer en geklassifiseer. Beskrywings van plantgemeenskappe sluit beskrywings van habitateienskappe, totale floristiese samestelling, lyste van differensiële spesiegroepe asook prominente spesies in die boom-, struik- en kruidstratunis in. Habitat-eienskappe wat met verskille in die plantegroei geassosieer is, is hoofsaaklik hoogte bo seespieël, aspek, helling, klipperigheid van die grondoppervlak, grond-diepte en grondtekstuur.

Die produk van die klassifikasie is natuurlike plantgemeenskappe. Die range van sintaksa is nie bepaal nie, omdat kennis van die plantegroei van die Bankenveld (Acocks, 1975) onvoldoende is.

REFERENCES

- ACOCKS, J. P. H., 1975. Veld types of South Africa. 2nd ed. *Mem. bot. Surv. S. Afr.* No. 40.
- BREDENKAMP, G. J. & THERON, G. K., 1976. Vegetation units for management of the grasslands of the Suikerbosrand Nature Reserve. *S. Afr. J. wildl. Res.* 6,2: 113-122.
- BREDENKAMP, G. J. & THERON, G. K., 1978. A synecological account of the Suikerbosrand Nature Reserve. I. The phytosociology of the Witwatersrand geological system. *Bothalia* 12: 513-529.
- COETZEE, B. J., 1974. A phytosociological classification of the Jack Scott Nature Reserve. *Bothalia* 11: 329-347.
- DU TOIT, A. C., 1954. *The geology of South Africa*. 3rd ed. Edinburgh: Oliver & Boyd.
- FOSBERG, F. R., 1967. A classification of vegetation for general purposes. In C. F. Peterken, *IBP Handbook 4, Guide to the checksheet for IBP areas* pp. 73-120. Oxford: Blackwell Scientific Publications.

ABSTRACT

RÉSUMÉ

VÉGÉTATION DES ZONES PÉRIODIQUEMENT INONDÉES DANS LE LIT MAJEUR DE LA RIVIÈRE PONGOLO

INTRODUCTION

THE STUDY AREA

[illegible]

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TABLE 1.—The duration of different flow rates on the Pongolo River Floodplain. High flows have the shortest duration. Data compiled from information provided by the Department of Water Affairs, Pretoria

River flow (cumecs)	Average number of days per year that flow exceeds stated value
28	102,0
56	41,0
85	20,0
113	11,0
141	8,0
170	5,0
198	4,0
226	3,0
255	2,5
283	2,0

waterbodies, locally referred to as pans (Hutchinson, Pickford & Schuurman, 1932). These have a total area of c. 2 600 ha (Musil, Grunow & Bornman, 1973), but this is reduced considerably by evaporation to less than 1 000 ha during the dry season.

Fluctuating water levels have been shown to influence both the species composition and the distribution of individual species in wetland areas (Howard-Williams, 1972; Howard-Williams & Walker, 1974; Howard-Williams, 1975). On the Pongolo River Floodplain some 8 000 ha lies between high flood level (HFL) and maximum retention level (MRL) of the pans, i.e. the level at which pan and river lose contact (Breen *et al.*, 1978), and is therefore normally only flooded for relatively short periods. A further approximately 1 000 ha becomes exposed gradually during the dry season as levels drop below MRL, and is therefore inundated for longer periods than that between HFL and MRL. The natural flooding regime has been altered by the impounding of the river at Jozini (Fig. 1), and the effects of these changed conditions on the floodplain vegetation will be discussed in a subsequent paper.

Inhabitants of the higher area immediately around the floodplain make extensive use of the alluvial soils for subsistence agriculture and most of the floodplain

vegetation is disturbed (Fig. 2). However, since a portion of the floodplain was incorporated in the Ndumu Game Reserve (Fig. 1) when it was established in 1924, a relatively undisturbed area was available for comparison.

METHODS

The Braun-Blanquet method of sampling and synthesis as described by Werger (1974) was adopted. Using aerial photographs, physiognomically distinct vegetation areas were demarcated and field checks were carried out to ensure that they were correctly assigned. Optimal plot size was determined by increasing the area until the number of species recorded remained more or less constant. Plot size was determined as 100 m² (5 m × 20 m) for the forest community and, although it may be adapted to vegetation type (Werger, 1974), all communities were sampled by 100 m² plots. A total of 106 plots was investigated during August and September 1974. All species present were listed and, since most annuals only appear after the floods have receded (usually in April), it is probable that most were still recognizable at the time of the survey.

After communities had been checked and demarcated on the aerial photographs (1:25 000), they were subjectively transcribed onto a map of the same scale.

The following site factors, soil pH in 1 N KCl (Jackson, 1958), and proportions of clay, silt and sand (Black, 1965), were determined. With the aid of 1:6 000 contour maps the height of each plot above MRL and below HFL was estimated.

Plant nomenclature follows Ross (1972).

THE PLANT COMMUNITIES

Six communities have been recognized and they may be grouped according to their relative periods of exposure and inundation: (1) the communities (two) of high-lying areas, which are only inundated for short periods; (2) those (three) of low-lying gently sloping areas, which only become exposed as water approaches and drops below MRL, i.e. those having the longest submergence and shortest period of exposure; and (3) the community which occupies the intermediate areas, where the slope is slightly steeper



FIG. 2.—An aerial view of part of the Pongolo River Floodplain showing the extensive cultivation along the levees and riverbank. Only small pockets of the *Ficus sycamorus* — *Rauvolfia caffra* Community remain outside the Ndumu Game Reserve.

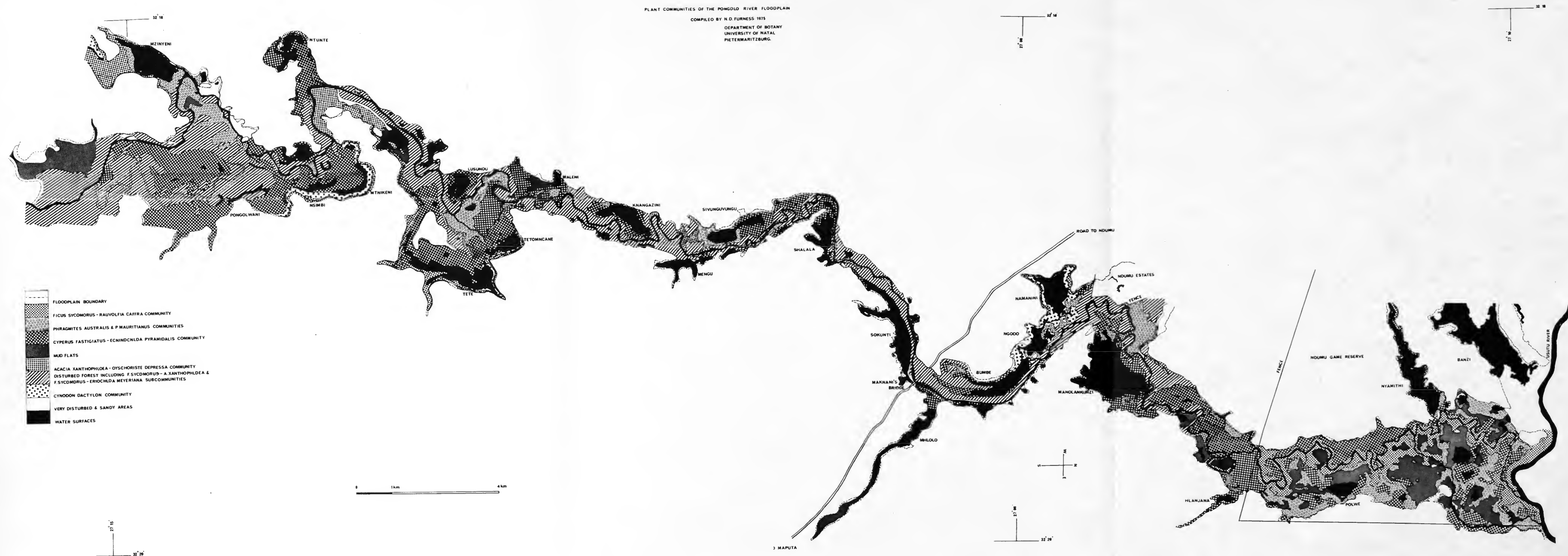


FIG. 3.—Map showing the distribution of the plant communities of the seasonally flooded areas of the Pongolo River Floodplain between Mzinyeni Pan and the confluence of the Pongolo and Usutu Rivers.

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FIG. 2.—An aerial view of part of the Pongolo River Floodplain showing the extensive cultivation along the levees and riverbank. Only small pockets of the *Ficus sycomorus* — *Rauvolfia caffra* Community remain outside the Ndumu Game Reserve.

so that water drains off fairly rapidly thereby preventing the development of communities typical of the low-lying areas.

1. Communities of the high-lying areas (Fig. 2)

Two communities may be recognized: the *Ficus sycomorus*—*Rauvolfia caffra* Community with two subcommunities, occupying 406 ha, which is restricted to levees on either side of the main river channel, and the *Acacia xanthophloea*—*Dyschoriste depressa* Community, 128 ha in extent, which is confined to narrow bands along the margin of the floodplain (Figs 3 & 4).

1.1 The *Ficus sycomorus*—*Rauvolfia caffra* Community

This community forms a distinct vegetational unit. Since most of the species present do not occur in any other community, they may be regarded as character or differential species (Table 2). They include *Ficus sycomorus*, *Rauvolfia caffra*, *Trichilia emetica*, *Entada spicata*, *Syzygium guineense*, *Adina microcephala*, *Allophylus decipiens*, *Kraussia floribunda* and *Monanthonotaxis caffra*.

Outside the Ndumu Game Reserve (Table 3: relevés 90, 65, 96, 81, 80, 87, 83 & 104), the community

usually has only two strata: a tall tree stratum (12–15 m), formed principally by *Rauvolfia caffra*, *Ficus sycomorus* and *Trichilia emetica* with cover of 60–80%, and a 2–3 m shrub stratum of *Allophylus decipiens*, *Grewia caffra*, *Monanthonotaxis caffra*, *Ficus capreifolia*, *Syzygium guineense* and *Adina microcephala* with cover of 10–20%. Within the reserve a further two strata of shade tolerant species are evident (relevés 73, 72, 68, 69, 70, 71 & 74), the taller (0.75–1.25 m, cover 15–20%) of *Dicliptera heterostegia* and *Setaria chevalieri*, while in some relevés (81 & 87) the grass *Opismenus hirtellus* forms a low stratum (0.1–0.25 m) with cover not exceeding 10%. The tendency for these two strata to be developed within the Reserve reflects the agricultural disturbance on the levees outside the Reserve.

Two sub-communities are recognizable:

(a) The *Ficus sycomorus*—*Eriochloa meyeriana* Sub-community

This develops where the impact of agriculture is severe. Because of clearing, the upper stratum (8–10 m, cover 40 %) is only occasionally present (Table 3: relevés 93, 91, 49 & 48), and the middle shrub and lower herb strata are poorly developed. The second stratum of *Dicliptera heterostegia*, *Monanthonotaxis caffra*, *Kraussia floribunda* and *Setaria chevalieri* is

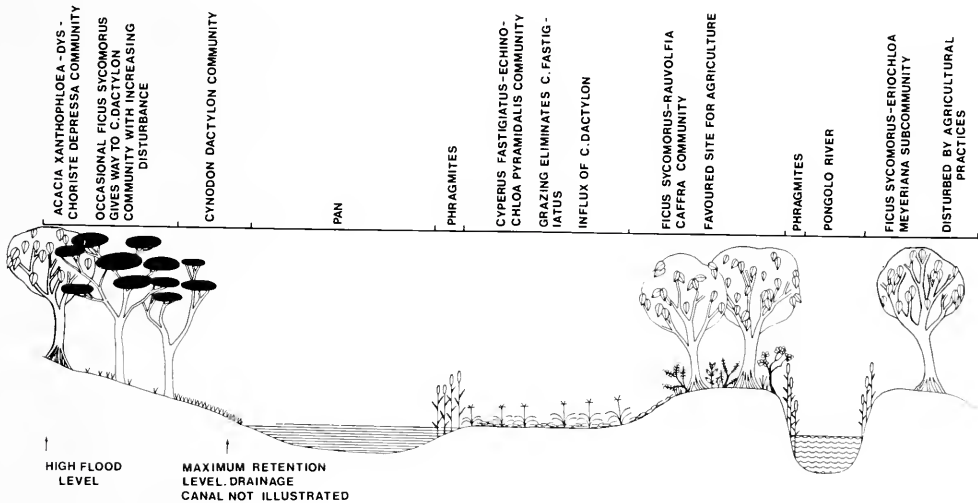


FIG. 4.—Diagrammatic representation of a cross-section of the Pongolo River Floodplain showing the relative positions of the different plant communities.

TABLE 2.—Character* and differential† species of the Floodplain communities

Community	Species	Community	Species
<i>Ficus sycomorus</i> — <i>Rauvolfia caffra</i>	<i>Ficus sycomorus</i> *† <i>Rauvolfia caffra</i> *† <i>Trichilia emetica</i> *† <i>Dicliptera heterostegia</i> *† <i>Entada spicata</i> *† <i>Adina microcephala</i> *† <i>Syzygium guineense</i> *† <i>Setaria chevalieri</i> *† <i>Ipomoea digitata</i> *† <i>Allophylus decipiens</i> *† <i>Kraussia floribunda</i> *† <i>Opismenus hirtellus</i> *† <i>Monanthonotaxis caffra</i> *†	<i>Acacia xanthophloea</i> — <i>Dyschoriste depressa</i>	<i>Acacia xanthophloea</i> *† <i>Dyschoriste depressa</i> *†
		<i>Cynodon dactylon</i>	<i>Cynodon dactylon</i> *
		<i>Cyperus fastigiatus</i> — <i>Echinochloa pyramidalis</i>	<i>Cyperus fastigiatus</i> *
		<i>Phragmites australis</i> <i>Phragmites mauritanus</i>	<i>Phragmites australis</i> *† <i>Phragmites mauritanus</i> *†

0.75–1.25 m tall with slightly higher cover (15%) compared with the *Ficus sycomorus*—*Rauvolfia caffra* Community. The lower stratum (0, 1–0.25 m, cover 15–60%) contains a number of species which is found in other communities e.g. *Sida alba*, *Eriochloa meyeriana* and *Commelina africana*. In moister areas, *Echinochloa pyramidalis* forms quite dense mats (relevés 49 & 48). The presence of opportunist species such as *Sida alba* and *Commelina africana*, and the extent (2 142 ha) and the distribution of this sub-community (Fig. 3) suggest that it results from disturbance. It is thus present along the levees and between the old and present river course north and east of Mzinyeni and south of Pongolwani Pans, sites that are favoured for agriculture and where, under undisturbed conditions, the *Ficus sycomorus*—*Rauvolfia caffra* Community would normally be present.

(b) *The Ficus sycomorus*—*Acacia xanthophloea* Sub-community

This sub-community has a very restricted distribution (10 ha, Fig. 2) and is represented only by two small stands (Table 3: relevés 86, 85 & 58).

Four strata are present, the upper (8–10 m, cover 40–50%) being comprised of *Ficus sycomorus*, *Acacia xanthophloea* and two climbers, *Ipomoea digitata* and *Jasminum fluminense*. The 2–4 m shrub stratum, dominated by *Ficus capreifolia* and *Grewia caffra*, but also containing *Acacia xanthophloea*, has relatively low cover (10–20%). A third stratum of approximately 0.75 m, comprising mainly *Kraussia floribunda*, *Mimosa pigra* and young *Acacia xanthophloea*, is present with cover not exceeding 30%. The lowest stratum (0.4 m) is characterized by both the greatest species diversity and, at times, the highest cover. Dominant species are *Dyschoriste depressa*, *Cissampelos mucronata*, *Eriochloa parvispiculata*, *Cardiospermum halicacabum*, *Hemarthria altissima*, *Eriochloa meyeriana* and *Echinochloa pyramidalis*.

The two sites where this sub-community has developed, to the south-west of Khangazini and west of Mengu Pans (Fig. 2), are areas where the river levees and the margin of the floodplain are close together. Such a situation would facilitate an intergrading of the *Ficus sycomorus*—*Rauvolfia caffra* and the *Acacia xanthophloea*—*Dyschoriste depressa* Com-

munities. This sub-community is therefore regarded as transitional.

1.2 *The Acacia xanthophloea*—*Dyschoriste depressa* Community (Fig. 5)

Acacia xanthophloea and *Dyschoriste depressa* are confined to this community and the *Ficus sycomorus*—*Acacia xanthophloea* Sub-community and they may, therefore, be regarded as either character or differential species (Table 2: relevés 99, 18, 53, 23, 16, 11, 13, 15, 17, 45, 102, 30, 26, 32, 36, 100, 98 & 75). A striking feature of this community is that it is formed of two strata only, the tree stratum being composed entirely of *Acacia xanthophloea* (8–12 m, cover 20–50%). The second stratum is made up of low-growing (0.15–0.45 m) herbs with sparse cover (usually 7–10%). *Dyschoriste depressa* is the most prominent, others being *Sida alba*, *Heliotropium ovalifolium*, *Heliotropium indicum*, *Cynodon dactylon*, *Ambrosia artemisiifolia* and *Cardiospermum halicacabum*. These latter species tend to be widely distributed and have low cover-abundance values (r or +). Many may be regarded as opportunists, reflecting the unstable conditions brought about by flooding and grazing. In some areas outside the relevés investigated a few well-established *Ficus sycomorus* are present. These stands are, however, not considered typical. They do, however, serve to indicate the close relationships between this community and the *Ficus sycomorus*—*Rauvolfia caffra* Community.

1.3 *Interrelationships*

Both communities of the high-lying areas develop on widely varying soils, usually slightly acidic (pH 4–6.6) and with extremely variable clay (9–68%), silt (3–49%) and sand (16–62%) fractions. This suggests that some other factor(s) predominate in determining their distribution. Because of topographical variation along the floodplain, different pans at MRL have different elevations with regard to both the river level and HFL. This has a striking influence on the vegetation, those communities intolerant of flooding being closely related to HFL, where those communities, which are more hygrophilous and more tolerant of flooding, have a distribution that is closely related to MRL irrespective of its height relative to HFL.



FIG. 5.—A view of the *Acacia xanthophloea* — *Dyschoriste depressa* Community taken during the extended summer floods of 1976. At this time the herb layer becomes incorporated into the aquatic system.

Fig. 6a reveals that although the distribution of both communities is relative to height below HFL, and therefore to the period of inundation while the river is in flood, the *Ficus sycomorus*—*Rauvolfia caffra* Community is the more sensitive to flooding in that it develops on the highest areas. Clearly, however, distribution of the community is not only determined by period of inundation, because it is absent from areas around the margin of the floodplain, even where they may have an almost identical flooding regime to that of the levees. It seems likely that seasonal availability of soil moisture acts in conjunction with inundation, because proximity to the river would prevent the development of the very dry conditions which arise along the edge of the floodplain during the dry winter months (unpublished data). The seasonally drier conditions along the margin of the floodplain eliminate *Monanthotaxis caffra* and other hygrophilous woody species, while the presence of occasional *Ficus sycomorus* suggests that it may be somewhat more tolerant. Although more favourable soil moisture conditions might be found at lower elevations along the floodplain margin, development of the woody component is prevented by the longer period of inundation. The combination of these factors is probably responsible for the distinct separation of the *Ficus sycomorus*—*Rauvolfia caffra* and *Acacia xanthophloea*—*Dyschoriste depressa* Communities.

The *Acacia xanthophloea*—*Dyschoriste depressa* Community tends to develop in slightly lower-lying areas than the *Ficus sycomorus*—*Rauvolfia caffra* Community, but above MRL (Fig. 4). It is, therefore, inundated only while the river is in flood, and the

period of inundation is greater than that experienced by the *F. sycomorus*—*R. caffra* Community.

2. The communities of low-lying areas

Three communities were recognized (Table 3). The *Phragmites australis* and the *P. mauritanus* Communities together occupy an area of c. 234 ha, most of which (65%) is in the Ndumu Game Reserve. The *Cyperus fastigiatus*—*Echinochloa pyramidalis* Community is one of the largest, covering c. 2 471 ha, with particularly extensive stands occurring west of Tete and Nsimbi Pans and in the Ndumu Game Reserve (Figs 3 & 7).

2.1 The *Phragmites australis* Community

This community is dominated by *Phragmites australis*, which may be regarded as the character/differential species (Table 2). Under protection in the Ndumu Game Reserve (Table 3: relevés 76 & 77), it forms dense stands growing to a height of 2.0–3.0 m with high cover-abundance values and few other species (relevés 76 & 77). Where its vitality is reduced by cutting and burning (relevés 92, 94 and 95), invasion by other species occurs, principally *Echinochloa pyramidalis* and *Eriochloa meyeriana* that form a stratum between 0.3 and 0.45 m.

2.2 The *Phragmites mauritanus* Community

Phragmites mauritanus is the dominant and differential species (Table 2), growing to a height of 1.5–3.5 m and forming dense stands with high cover-abundance values (Table 3). It is usually associated

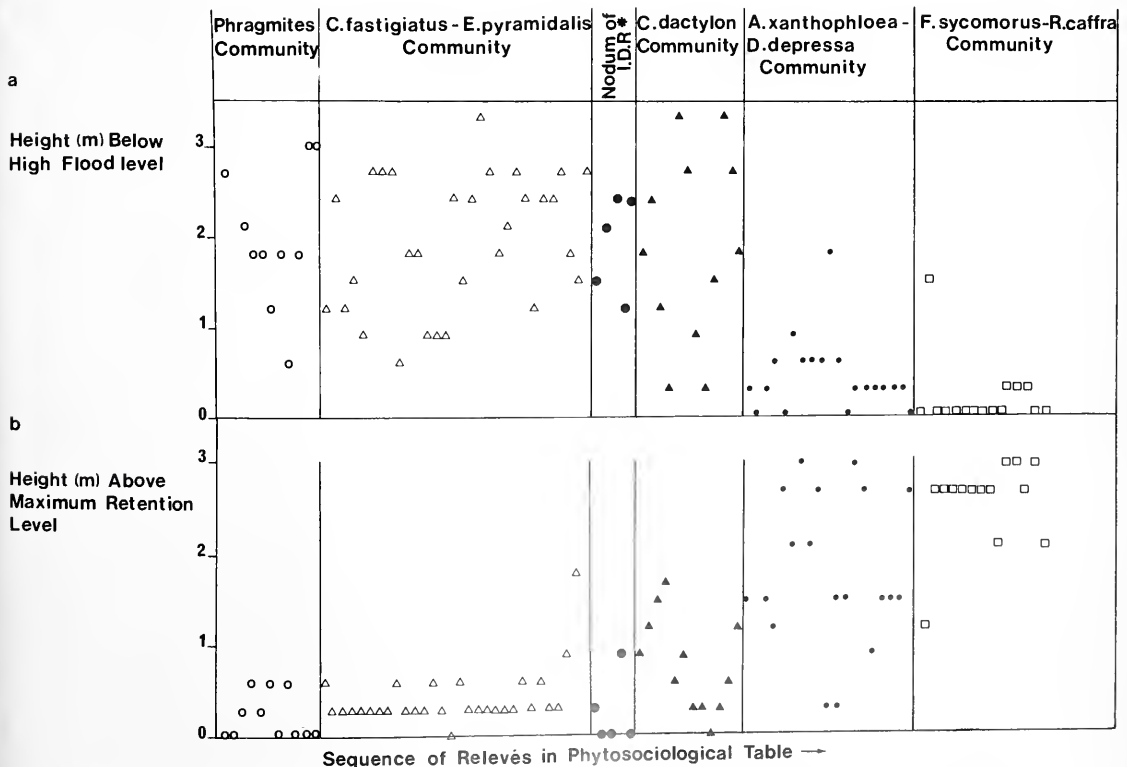


FIG. 6.—Position of the relevés relative to: (a) height below high flood level; (b) height above maximum retention level. Relevés are ordered in the sequence defined by the phytosociological Table 3. *Nodum of indeterminate rank.

with *Echinochloa pyramidalis* and *Alternanthera sessilis*, although other species are also found in this community (e.g. *Eriochloa meyeriana*, *Sida alba* and *Cynodon dactylon*), particularly outside the Ndumu Game Reserve. Only one relevé (64) was, however, examined within the Reserve. Where present, these species form a low-growing stratum (0.15–0.4 m) with low cover-abundance values.

2.3 The *Cyperus fastigiatus*—*Echinochloa pyramidalis* Community (Fig. 7)

Cyperus fastigiatus and *Echinochloa pyramidalis* are differential species (Table 2), for this community (Table 3) and, when they have high cover-abundance values (relevés 59 & 105), few other species are present. Where cover-abundance of the differential species is lower, opportunist species such as *Glinus lotoides*, *Heliotropium indicum* and *Cardiospermum halicacabum* are more common. Three strata may be recognized, an upper comprising mainly *Cyperus fastigiatus* (1–2 m; cover 20–80%), intermediate (0.3–0.4 m; cover 15–80%) dominated by *Echinochloa pyramidalis*; and a layer formed by prostrate species such as *Cynodon dactylon* and *Polygonum aviculare* (0.1–0.15 m; cover 5–20%).

2.4 Interrelationships

The three communities of the low-lying areas all develop on acidic soils with a pH of 3.3–6.4 and of rather variable texture (Table 3). It seems that the *Phragmites australis* Community develops on soils that are more sandy (27–73%) than those of the *Phragmites mauritanus* and *Cyperus fastigiatus*—*Echinochloa pyramidalis* Communities (10–57%).

The development of all three communities is closely associated with MRL (Fig. 6b). This suggests that it is not so much inundation as the presence of a more stable water supply that controls the position of these communities. The *Phragmites* Communities tend to occupy the lower positions, *P. australis* favouring swampy areas as opposed to *P. mauritanus*, which prefers sites where there is water movement, such as river banks. The *Cyperus fastigiatus*—*Echinochloa pyramidalis* Community develops only on flat and gently sloping draining areas adjacent to pans, and in

depressions that remain wet for most of the dry season (Fig. 4).

The *Cyperus fastigiatus*—*Echinochloa pyramidalis* Community shows marked affinities with the *Phragmites* Communities through the extension of the distribution of *Echinochloa pyramidalis* into these semi-aquatic habitats, and with the *Cynodon dactylon* and *Acacia xanthophloea*—*Dyschoriste depressa* Communities because of the presence of *Cyperus fastigiatus* in these higher-lying areas. The degree to which these rather broad distributional patterns reflect the distribution under natural and undisturbed conditions is debateable, because reduction in the cover of the *Phragmites* Communities might favour intrusion of *Echinochloa pyramidalis*, whereas grazing of *Cyperus fastigiatus* seems to favour an increase in the *Cynodon dactylon* component. Where both differential species are grazed, particularly in the areas west of Sivunguvungu and to the south and south-west of Khangazini Pans, their cover-abundance values are lower and a wider variety of species is present (Table 3: relevé 46, 38 & 39).

3. Communities of intermediate areas

Only one community, the *Cynodon dactylon* Community, has been recognized, covering 171 ha of the floodplain. It is generally found on gently sloping areas that become exposed gradually as the floodwaters recede (Table 3, Fig. 6). The soils vary from acidic (pH 4.5) to almost neutral (pH 6.8), with very variable texture: clay 29–73%, silt 6–36% and sand 11–63%. *Cynodon dactylon* is extremely tolerant of extended periods of dry conditions following exposure, and of submergence. Not surprisingly, therefore, the distribution of the *C. dactylon* Community does not show marked relationships with either height above MRL or below HFL (Fig. 6a & b). It therefore extends from below maximum retention level to above high flood level (Fig. 4). *C. dactylon* may be found in all the communities, particularly where disturbance has occurred.

3.1 The *Cynodon dactylon* Community (Fig. 8)

Cynodon dactylon, the differential species (Table 2) for this community, forms dense, almost pure, stands



FIG. 7.—A good example of the *Cyperus fastigiatus*—*Echinochloa pyramidalis* Community. This stand on the north-western edge of Tete Pan has been reduced in size and in height. Most of the area is now a mixture of *Cyperus fastigiatus*, *Echinochloa pyramidalis* and *Cynodon dactylon* forming a stratum of about 50 cm in height.



FIG. 8.—The *Cynodon dactylon* Community is grazed extensively during the late winter period when pasturage elsewhere is low.

of considerable extent around some pans (e.g. Namanini-Bumbe 42 ha, east of Mthikeni and Nsimbi 27 ha). It forms a single stratum (0.2 m) with up to 90% cover where conditions are most favourable (Table 3: relevés 5, 8 & 10). Elsewhere, where cover is reduced (relevés 27 & 28), and grazing more intense, the height may be less (0.05 m) and the weeds (*Ambrosia artemisiifolia*, *Conyza bonariensis* and *Polygonum aviculare*) become more prominent. These species form an ill-defined stratum of 0.2–0.3 m in height.

3.2 Interrelationships

The close relationships of the *Cynodon dactylon* Community with other communities on the floodplain are emphasized not only by the distribution of *C. dactylon*, but also by five relevés (56, 21, 19, 35 & 20) that form a nodule of indeterminate rank between the *C. dactylon* and *Cyperus fastigiatus*–*Echinochloa pyramidalis* Communities.

It seems probable that this community would normally develop in areas where the inundation period was too long for the woody communities and where it became too dry for communities characteristic of the low-lying areas (Fig. 6). Since it presently extends into areas that clearly show relics of other communities, it must be concluded that disturbance has increased the extent of this community. At the lower levels it is principally by replacement of *Cyperus fastigiatus*, which is adversely affected by grazing and trampling and, at higher levels, by clearing, which reduces competition and allows more direct illumination, both of which favour *Cynodon dactylon*.

4. Relevés of undetermined affinity

Six relevés (50, 12, 47, 41, 60 & 62) do not appear to fit satisfactorily into the communities outlined above. Although they could have been allocated to specific communities, thereby improving the information on total floristics, the degree of affinity did not, in our opinion, justify this action. They are included in the table because an advantage of the Braun-Blanquet method is that new relevé data may continuously be added, thereby facilitating recognition of communities that may not be presently recognizable (Werger 1973).

DISCUSSION

The studies by Tinley in 1958 (published in 1976) are the earliest reports on the Pongolo River Floodplain vegetation. He recognized two formations, the

Riparian Forest, which included the disturbed and undisturbed vegetation of the levees and high-lying margins of the floodplain, and the Aquatic and Marginal Pan Vegetation. This broad classification, which does not take into account the observed marked influence of the flooding regime, does not agree well with the community distinctions drawn up in this study.

More recently, De Moor *et al.* (1977) and Pooley (1978) have reported on the vegetation within the Ndumu Game Reserve (Fig. 1). Only a portion of this Reserve includes the floodplain of the Pongolo River. De Moor *et al.* (1977) using the system of Fosberg (1967), recognized six formations (Table 4) of which five corresponded well with those recognized in this study. The microphyllous deciduous shrub savanna is, however, difficult to relate to our communities, because it includes species such as *Sesbania sesban*, *Echinochloa pyramidalis* and *Phragmites australis*, which appear to exhibit markedly different responses to inundation, and it therefore probably forms a transition between “forest and grasses” as has been suggested by Pooley (1978). Neither De Moor *et al.* (1977) nor Pooley (1978) have, however, attempted to relate the plant communities to flooding regimes.

TABLE 4.—Comparison of the formations determined by De Moor *et al.* (1977) with communities of this study

De Moor <i>et al.</i> (1977)			Present study
Formation			Community
1	Dry season deciduous forest		<i>Ficus sycomorus</i> — <i>Rauwolfia caffra</i>
4	Tall evergreen marsh	graminoid	<i>Phragmites mauritanicus</i>
4a	Tall evergreen marsh	graminoid	<i>Phragmites australis</i>
4b	Seasonal orthophyll tall grass		<i>Cyperus fastigiatus</i> — <i>Echinochloa pyramidalis</i>
4c	Microphyllous shrub savanna	deciduous	Probably transitional between <i>Cyperus fastigiatus</i> — <i>Echinochloa pyramidalis</i> and <i>Ficus sycomorus</i> — <i>Rauwolfia caffra</i>
5	Seasonal orthophyll meadow		<i>Cynodon dactylon</i>

Werger (1974a) has suggested that in areas exposed to extreme conditions, emphasis should be placed on permanently recognizable species in phytosociological analysis. This concept was applied to the floodplain

vegetation because, particularly above MRL where both inundation and exposure have to be tolerated, conditions may be considered to be extreme. It reduces the number of species from 64 to 25, but does not alter the definitions of the communities (Table 5).

None of the communities recognized on the Pongolo River Floodplain is unique. They have been recorded from widely separated areas on the African continent, on floodplains and areas of fluctuating water levels.

Phragmites australis and *P. mauritanicus* have a world-wide distribution (Clayton, 1967; Fernandes *et al.*, 1971), although *P. mauritanicus* tends to be more tropical and is frequently encountered in swampy and seasonally flooded areas (Gordon-Gray & Ward, 1971; Howard-Williams & Walker, 1974; Rzóška, 1974). The distinction in ecological preference between *P. australis*, which favours standing water, and *P. mauritanicus* which prefers moving water, supports the observations of Gordon-Gray & Ward (1971). Howard-Williams & Walker (1974) reported similar environmental conditions in stands of *P. mauritanicus* in Lake Chilwa, although it was also present in alkaline swamps. In other parts of Central Africa, Vesey-Fitzgerald (1963) recorded *Phragmites* in Riverine Grasslands and "lakes" where it formed dense stands on silt banks, sand bars and in lagoons. He did not record it from "pans" or "alkaline swamps and flats", but this may, in the former instance, reflect the fact that the pans being investigated were shallow depressions that normally dried up during the dry season. They are clearly different from those of the Pongolo system. Vesey-Fitzgerald did not record the specific names of *Phragmites* and from the distribution (Clayton, 1967; Fernandes *et al.*, 1971) it seems likely that, although both *P. australis* and *P. mauritanicus* could have been present, *P. mauritanicus* would be the more common.

Cyperus fastigiatus is widespread in the province of Natal in South Africa (Ross, 1972), but has not been recorded in tropical areas (Vesey-Fitzgerald, 1955; 1963; Dean, 1967; Cook, 1968; Howard-Williams & Walker, 1974; Imevbore & Bakare, 1974; Rzóška, 1974). Ross (1972) claims that *C. fastigiatus* is closely allied to the more tropical *C. auricomus* Sieber ex Spreng., which is also placed with *C. digitatus* Roxb. subsp. *auricomus* by Kükenthal (in Ross, 1972). Howard-Williams & Walker (1974) reported *C. digitatus* from relatively acidic soils (pH below 6.0) in their neutral to acidic marsh vegetation type. These conditions are similar to those in which *C. fastigiatus* is found on the Pongolo system.

Unlike *Cyperus fastigiatus*, *Echinochloa pyramidalis* is widespread in wet areas where it is often associated with a variety of other species (Vesey-Fitzgerald, 1955; 1963; Dean, 1967; Cook, 1968; Imevbore & Bakare, 1974; Howard-Williams & Walker, 1974). The description of its growth in floodplain grassland by Vesey-Fitzgerald (1963) aptly describes its behaviour in the Pongolo system: "Growth starts at the onset of the rains but the stature depends on the extent of flooding. Under optimum conditions the previous season's accumulation of rough roots away in the water and the new growth is very vigorous". Although *E. pyramidalis* is grazed by hippopotamus (Scotcher *et al.*, 1978), the numbers of hippopotamus outside the Ndumu Game Reserve on the Pongolo Floodplain are small and they do not exert a marked effect. However, as soon as the floods recede and the marshy areas become dry enough for cattle, both

E. pyramidalis and *C. fastigiatus* are grazed. As in tropical areas, even when drying out and being grazed, node shoots remain green until quite late in the season. In areas where grazing is particularly heavy and where drainage is slightly more rapid following the floods, *E. pyramidalis* may form a mosaic with *Cynodon dactylon* as has been observed by Vesey-Fitzgerald (1955) and Dean (1967).

The development of *Cynodon dactylon* Communities under conditions of fluctuating water levels is well documented, both as pure stands (Lea & Van V. Webb, 1939; Vesey-Fitzgerald, 1955; Dean, 1967; Greenway & Vesey-Fitzgerald, 1969) and in association with other species (Lea & Van V. Webb, 1939; Burnett, 1951; Anderson & Herlocker, 1973; Howard-Williams & Walker, 1974). These short-grass lawns develop on a wide range of soils from acid to alkaline in areas where prolonged flooding is not experienced. Dean (1967) noted that *C. dactylon* was easily killed by flooding. On the Pongolo, it regularly tolerates periods of submergence of up to 150 days, apparently without much detrimental effect.

During summer the *C. dactylon* around the pans may be inundated, thereby becoming an integral part of the aquatic system. Even if it is not completely inundated, the substrate is generally too wet for access by cattle and goats. Thus it is only during the drier parts of the year that these lawns become accessible to terrestrially based grazers, for which it provides a valuable source or pasturage.

The distribution of *Acacia xanthophloea* along tropical and sub-tropical river courses and in damp depressions is well documented (Anderson & Herlocker, 1973; Greenway & Vesey-Fitzgerald, 1969). Vesey-Fitzgerald (1974) concluded that the cyclic and seral status of groves of *A. xanthophloea* were substantially influenced by drainage conditions. A consequence of this is that trees along the lake-shore may succumb during periods of high lake levels (Greenway & Vesey-Fitzgerald, 1969), a situation observed on the Pongolo Floodplain particularly in the vicinity of Mzinyeni Pan (Figs 1 & 5) during the unnaturally extended floods caused by discharge of water from the Pongolopoort Dam after its construction.

Ficus sycomorus occurs throughout Africa along river courses, swampy areas and even arid areas where the water table is high (Palmer & Pitman, 1972). Site preference seems to be for those areas where drainage is quite good and yet water is freely available, because the best stands on both the Pongolo Floodplain (in the Ndumu Game Reserve) and in Lake Manyara National Park (Greenway & Vesey-Fitzgerald, 1969) are along the tops of the river banks and levees.

This study has illustrated the importance of the flooding regime in the development of the vegetational communities. As a result, changes in the pattern of flooding, both of frequency and perhaps more importantly of duration of inundation and exposure, can be expected to exert a profound effect on the communities, as has been observed elsewhere (Dean, 1967; Townsend, 1975; Attwell, 1970). With the very sandy nature of the soils of the floodplain, particularly of the levees and around the pans, destruction of vegetation, resulting either directly from changes in the flooding pattern, or indirectly as a result of allowing cultivation and grazing in areas that were formerly too wet, could increase erosion, thereby having a profound impact on the floodplain system as a whole.

TABLE 5.—Communities of the Pongolo River Floodplain delineated on the permanently recognizable species only

	Phragmites australis community	Phragmites mauritianus community	Cyperus fastigiatus-Echinochloa pyramidalis community	Numm of indeterminate rank	Cynodon dactylon community	Acacia xanthophloea-dyschoriste depressa community	F. sycamorua - A. xanthophloea sub-community	F. sycomorua - F. meyeriana sub-community	Ficus sycomorua - Rauwolfia caffra community
Phragmites australis (Cav.) Trin. ex Steud.	55221			1					
Phragmites mauritianus Kunth		444554		+					
Echinochloa pyramidalis (Lam.) Hitchc. & Chase	2122	443323	4243241-3234222214+2+1+311	1		1			
Cyperus fastigiatus Rottb.	+		23443333231322333323224322321	++++1		+			
Cynodon dactylon (L.) Pers.	2 1		+	1 111	543443445343	+2+r 11+1 1+11			
Acacia xanthophloea Benth.					3+3233333323332333				
Dyschoriste depressa Nees					r1r+11+ +2+1 + 2				
Ficus sycomorua L.							333	33223	333333343344432
Rauwolfia caffra Sond.							+		33433222312313
Trichilia emetica Vahl.							1	1 2	221222212222
Dicliptera heterostegia Presl ex Nees non Chev.								+2+	22212222r 2 +
Entada spicata (E.Mey.) Druce									11111111r1+ 1
Adina macrocephala (Del.) Hiern.									+11r1+ +
Syzgium guineense (Willd.) D.C.									1+111 +
Setaria chevaliere Stapf ex Stapf & C.E.Hubb.			+					+	2+r 1 +r r
Ipomoea digitata L.							++	1+	2+++ + 1
Allophylus decipiens (Sond.) Radlk.									11 1++ r
Grewia caffra						1r	2+	2	1 + + 4 +1+3
Ficus capreifolia Del.	+			1			1+	2r	r + +21 1 2
Kraussia floribunda Harv.							r	+	++1+
Opismenus hirtellus (L.) Beauv.								+	+1 1 2+
Monanthotaxis caffra (Sond.) Verde.								+	+ 22 1
Jasminum fluminense Vell.							1+r	++	
Sesbania sesban (L.) Merrill		1	+			r	1		
Mimosa pigra L.		r	r	++			1		

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UITTREKSEL

Die Braun-Blanquet-metode van fitososiologiese analise is gebruik om die plantgemeenskappe van die seisoen-oorstroomde gebiede van die Pongolorivier-vloedvlakte te identifiseer. Ses gemeenskappe en twee subgemeenskappe, waarvan die verspreiding nou in verband staan met die periodes van relatiewe blootstelling en onderwatersetting, is onderskei. Die struktuur en onderlinge verwantskappe van die gemeenskappe is in ag geneem en kommentaar is gelewer oor die invloed van menslike aktiwiteite op die omvang daarvan. Vergelykings met soortgelyke situasies elders in Afrika is getref.

REFERENCES

- ANDERSON, G. D. & HERLOCKER, D. J., 1973. Soil factors affecting the distribution of the vegetation types and their utilization by wild animals in Ngorongoro Crater, Tanzania. *J. Ecol.* 61: 627-651.
- ATTWELL, R. I. G., 1970. Some effects of Lake Kariba on the ecology of a floodplain of the mid-Zambezi valley of Rhodesia. *Biol. Conserv.* 2: 189-196.
- BEGG, G. W., 1973. The biological consequences of discharge above and below Kariba Dam. *Proceedings of the Conference of the International Commission on Large Dams*. Madrid, 1973.
- BLACK, C. A. (editor-in-chief), 1965. *Methods of soil analysis*. Madison, Wisconsin: American Society of Agronomy.
- BREEN, C. M., FURNESS, H. D., HEEG, J. & KOK, H., 1978. Bathymetric studies on the Pongolo River Floodplain. *J. Limnol. Soc. s.th. Afr.* 4: 95-100.
- BURNETT, G. F., 1951. Field observations on the behaviour of the Red Locust, *Nomadacris septemfasciata* (Serville) in the solitary phase. *Anti Locust Bull.* 8: 1-37.
- CLAYTON, W. D., 1967. Studies in the Gramineae XIV. *Kew Bulletin* 21: 111-118.
- COOK, C. D. K., 1968. The vegetation of the Kainji Reservoir site in northern Nigeria. *Vegetatio* 15: 225-243.
- DEAN, G. J. W., 1967. Grasslands of the Rukwa Valley. *J. Appl. Ecol.* 4: 45-57.
- DE MOOR, P. P., POOLEY, E., NEVILLE, G. & BARICHIEVY, J., 1977. The vegetation of Ndumu Game Reserve, Natal: a quantitative physiognomic survey. *Ann. Natal Mus.* 23: 239-272.
- FERNANDES, A., LAUNERT, E. & WILD, H., 1971. Flora Zambeziaca 10: 91-94.
- FOSBERG, F. R., 1967. A classification of vegetation for general purposes. In G. F. Peterken, *Guide to the check sheet for I.B.P. areas* pp. 73-116. Oxford: Blackwell Scientific Publications.
- GORDON-GRAY, K. D. & WARD, C. J., 1971. A contribution to the knowledge of *Phragmites* (Gramineae) in South Africa, with particular reference to Natal populations. *Jl S. Afr. Bot.* 37: 1-30.
- GREENWAY, P. J. & VESEY-FITZGERALD, D. F., 1969. The vegetation of Lake Manyara National Park. *J. Ecol.* 57: 127-149.
- HOWARD-WILLIAMS, C., 1972. Limnological studies in an African swamp: seasonal and spatial changes in the swamps of Lake Chilwa, Malawi. *Arch. Hydrobiol.* 70: 379-391.
- HOWARD-WILLIAMS, C., 1975. Seasonal and spatial changes in the composition of the aquatic and semi-aquatic vegetation of Lake Chilwa, Malawi. *Vegetatio* 30: 33-39.
- HOWARD-WILLIAMS, C. & WALKER, B. H., 1974. The vegetation of a tropical African lake: classification and ordination of the vegetation of Lake Chilwa (Malawi). *J. Ecol.* 62: 831-854.
- HUTCHINSON, G. E., PICKFORD, G. E. & SCHURMAN, J. F. M., 1932. A contribution to the hydrobiology of pans and other inland waters of South Africa. *Arch. Hydrobiol.* 24: 1-154.
- IMEVBORE, A. M. A. & BAKARE, O., 1974. A pre-impoundment study of swamps in the Kainji Lake Basin. *Afr. J. Trop. Hydrobiol. and Fish.* 3: 79-93.
- JACKSON, M. L., 1958. *Soil chemical analysis* Englewood Cliffs, N.J.: Prentice-Hall.
- LEA, A. & WEBB, D. VAN V., 1939. Field observations on the Red Locust at Lake Rukwa in 1936 and 1937. *Sci. Bull. Dep. Agric. For. Un. S. Afr.* 189.
- MUSIL, C. F., GRUNOW, J. O. & BORNMAN, C. H., 1973. Classification and ordination of aquatic macrophytes in the Pongolo River pans, Natal. *Bothalia* 11: 181-190.
- PALMER, E. & PITMAN, N., 1972. *Trees of Southern Africa*. Cape Town: Balkema.
- PHÉLINES, R. F., COKE, M. & NICOL, S. M., 1973. Some biological consequences of the damming of the Pongolo River. *Proceedings of the Conference of the International Commission of Large Dams*. Madrid, 1973.
- POOLEY, E., 1978. A checklist of the plants of Ndumu Game Reserve, North-eastern Zululand. *Jl S. Afr. Bot.* 44: 1-54.
- ROSS, J. H., 1972. The flora of Natal. *Mem. bot. Surv. S. Afr.* No. 39.
- RZÓSKA, J., 1974. The Upper Nile swamps, a tropical wetland study. *Freshwat. Biol.* 4: 1-30.
- SCOTCHER, J. S. B., STEWART, D. R. M. & BREEN, C. M., 1978. The diet of the hippopotamus in Ndumu Game Reserve, Natal, as determined by faecal analysis. *S. Afr. J. Wildl. Res.* 8: 1-11.
- TINLEY, K. L., 1976. *The ecology of Tongaland*. Durban: The Natal Branch of the Wildlife Society of S.A.
- TOWNSEND, G. H., 1975. Impact of the Bennett Dam on the Peace-Athabasca Delta. *J. Fish. Res. Bd. Can.* 32: 171-176.
- VESEY-FITZGERALD, D. F., 1955. The vegetation of the outbreak areas of the Red Locust (*Nomadacris septemfasciata* Serv.) in Tanganyika and Northern Rhodesia. *Anti Locust Bull.* 20: 1-31.
- VESEY-FITZGERALD, D. F., 1963. Central African grasslands. *J. Ecol.* 51: 243-274.
- VESEY-FITZGERALD, D. F., 1974. The changing state of *Acacia xanthophloea* groves in Arusha National Park, Tanzania. *Biol. Conserv.* 6: 40-47.
- WELCOMME, R. L., 1974. *The fisheries ecology of African floodplains*. Rome: Food and Agriculture Organisation of the United Nations.
- WERGER, M. J. A., 1973. *Phytosociology of the Upper Orange River Valley, South Africa*. Ph.D. thesis, University of Nijmegen, Holland.
- WERGER, M. J. A., 1974. On concepts and techniques applied in the Zürich-Montpellier method of vegetation survey. *Bothalia* 11: 309-323.
- WERGER, M. J. A., 1974a. Applicability of Zürich-Montpellier methods in African tropical and subtropical range lands. In R. Tuxen, *Handbook of Vegetation Science* p. 13. The Hague: W. Junk.
- WERGER, M. J. A., KRUGER, T. J. & TAYLOR, H. C., 1972. A phytosociological study of the Cape fynbos and other vegetation at Jonkershoek, Stellenbosch. *Bothalia* 10: 599-614.

Phytogeography of fynbos

H. C. TAYLOR*

ABSTRACT

Previous classifications of the vegetation of the Cape Floristic Region, or Capensis, are outlined. The distinctive features of the Cape flora such as species diversity, endemism and distribution patterns are discussed in an attempt to elucidate the origins and evolution of the principal vegetation type of the region, known today as fynbos. Evidence suggests that the present species-rich Cape flora has mainly evolved in and radiated from the southwestern part of Capensis, an area where a true mediterranean-type climate is found.

RÉSUMÉ

PHYTOGÉOGRAPHIE DU FYNBOS

On rappelle schématiquement des classifications antérieures de la région floristique du Cap, ou Capensis. Les caractères distinctifs de la flore du Cap, tels que la diversité des espèces, l'endémisme et les modèles de distribution sont discutés pour tenter d'élucider les origines et l'évolution du principal type de végétation de la région, connu aujourd'hui sous le nom de fynbos. Les indices disponibles suggèrent que la flore du Cap actuelle, avec sa richesse en espèces, a principalement évolué dans le sud-ouest de la province du Cap et a rayonné à partir de cette région qui possède un climat de vrai type méditerranéen.

INTRODUCTION

In recent works both Takhtajan (1969) and Good (1974) allocated the rank of Kingdom to the Cape flora despite its small area on a world scale, thus according it equivalent phytogeographical importance to such vast regions as the Holarctic Kingdom which encompasses the whole of the temperate and arctic northern hemisphere.

The Cape Floral Kingdom is concentrated in the region known today as Capensis, the Cape folded-mountain belt, that comprises the distinctive temperate floral area of the southwestern and southern Cape Province occurring between latitudes 31° and 35° south and longitudes between 18° and 27° east. The western part has a distinctly mediterranean-type climate with dry summers and wet winters but eastward the rainfall becomes increasingly non-seasonal. Over the area as a whole, rainfall varies from extremes of 300 to 3 000 mm.

Capensis is bounded to the west and south by the coast and to north and east principally by the Karoo-Namib Region (Werger, 1978a) together with some outliers of the Sudano-Zambezian (Werger & Coetzee, 1978) and Afromontane Regions (White, 1978). The Karoo-Namib flora penetrates into Capensis in the Little Karoo, an arid area between the coastal and inland mountains (Werger, 1978a). On mountains in the Knysna region Capensis intergrades with the Afromontane flora, and several Cape species such as *Berzelia intermedia*, *Diospyros glabra*, *Leucadendron eucalyptifolium* and *Protea cynaroides* become dominant as one ascends from foothill forest to Mountain Fynbos (White, 1978).

The vegetation of Capensis consists principally of fynbos, a broad category of diverse evergreen sclerophyllous shrublands comprising Acocks's (1975) veld types 47 (Coastal Macchia), 69 (Macchia) and 70 (False Macchia), but includes two transitional veld types, Coastal Renosterbosveld and Strandveld, that contain a mixture of Cape and other floristic elements.

The broad phytogeographic demarcation of Capensis began in the last century when botanical travellers included "the region of the Cape flora" in their descriptions of vegetation formations and floristic

kingdoms. Among these pioneers were Schouw (1823), Drège & Meyer (1843), Grisebach (1872), Rehmann (1880), Engler (1882), Drude (1887, 1890) and Schimper (1898). Their vegetation descriptions and maps, based on scant information, were largely conjectural, and are of mere historical interest today.

From the turn of the century, resident botanists like Bolus (1886, 1905) and Marloth (1906, 1908) began to describe and map the vegetation of South Africa. Fynbos delineation was gradually refined by Bews (1916), Pole Evans (1936), Adamson (1938a) and others, until finally Acocks (1953) in his well-known map that is still in use today, recognized the three fynbos types mentioned above. In his discussion of these and later works, Werger (1978b) concludes that reasonable unity of opinion on the zoogeographical boundaries in Africa was reached much earlier than was the case with phytogeographical boundaries. The latter are, indeed, still being debated (e.g. Axelrod & Raven, 1978) and a clear picture will only emerge when the taxonomy and distribution of present floras, including lower plant groups, are known in detail.

CHARACTERISTICS AND AFFINITIES

The singular biogeographic features that led phytogeographers to give the Cape flora such a high status in their classifications include the great concentration of species, the high degree of endemism, the characteristic distribution patterns of typical elements despite a general lack of species dominance, and the predominance of certain families and genera. The Cape flora "is noted for its richness in species, both in small areas and over its whole range" (Taylor, 1978), and has been claimed as being one of the richest in the world for its size (Oliver, 1977). For diversity at the community level (alpha diversity), Taylor (1972) has recorded 121 species of flowering plants in a single 100 m² quadrat in a homogeneous stand of Mountain Fynbos. This figure, although probably not the final tally, considerably exceeds the average level of alpha diversity in equivalent shrubland communities of mediterranean-type ecosystems elsewhere (Kruger *et al.*: paper delivered at the Second International Symposium on African Wildlife Management and Research, Pretoria, July 1977). Plant species richness at the landscape level, such as a mountain

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range (gamma diversity—Whittaker, 1972), is much greater than that of southwestern Australia, the richest floristic zone in that continent (Kruger, 1977); while at the level of a floristic kingdom or province, Goldblatt's (1978) figure of 8550 species of vascular plants in the Cape Floristic Region compares well with the figure of 7 000 given by McLarty (1952) for the whole of Western Australia, an area about twenty times that of Capensis.

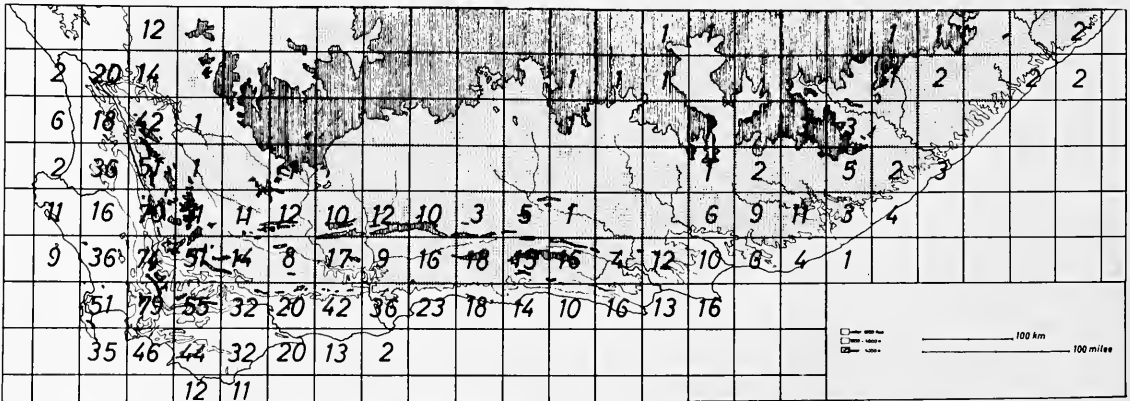
Two of the three families that are characteristic of the Cape flora, Restionaceae and Proteaceae, have a pronounced austral distribution. Both of them occur on all three southern continents and have very few representatives north of the equator. The third Cape family, Ericaceae, has no connections with either of the other two southern continents. Its subfamily Ericoideae that occurs in the Cape has a strictly north-south distribution. All three families have strong concentrations of taxa in Capensis. Outliers occur on mountains not only in adjacent dry areas to the north, especially Namaqualand (Adamson, 1938b), but also intermittently along the eastern highlands of the continent as far north as central Africa (Oliver, 1977). Many other typical Cape taxa have similar distribution patterns. In fact there are so many in the Drakensberg that both Killick (1963, 1978) and Edwards (1967) have described a type of "fynbos" for that area, and Boughey (1957), Hedberg (1965) and Wild (1968) have recognized a "Cape element" on the mountains of Rhodesia and East Africa. But the floras of high mountains in southern and central Africa are incompletely known and intensive plant collecting is needed to provide data for a full phylogeographic study of these interesting migration routes.

Families that are richest in genera at the Cape but widely distributed in other parts of the world include Fabaceae, Iridaceae, Rosaceae and Thymelaeaceae. In contrast, many taxa of high rank are endemic to the Capensis region or nearly so. These include Bruniaceae, Penaeaceae, Stilbaceae, Grubbiaceae, Roridulaceae and Geissolomataceae, the tribe Diosmae of the Rutaceae and large genera such as

Aspalathus, *Phylica*, *Muraltia* and *Cliffortia* (Oliver, 1977; Axelrod & Raven, 1978; Taylor, 1978). Weimarck (1941) found that of 282 genera with their centre of origin in Capensis, 212 were endemic, and he estimated that more than 3 500 species were endemic out of the total of 4 200 that he surveyed. In examining local endemism, Weimarck found that the two westernmost centres together contained 45.5 percent of the total number of endemics represented within the "Cape proper."

Taxonomic studies show that both palaeo-endemics, or relics, and neo-endemics, or recently evolved species that are still limited to a small area, occur in the Cape flora. These types have local or disjunct distributions or both. The Proteaceous species *Orothamnus zeyheri*, *Mimetes hottentoticus* and *Leucadendron argenteum* are, by virtue of their distribution and biology, considered to be palaeo-endemics. Rourke (1972) reports vicariad groups of neo-endemic *Leucospermum* species on coastal lowlands of the southern Cape and Levyns (1954) shows that several *Muraltia* species occupying the same coastal strip are also youthful endemics. From phylogenetic evidence, Oliver (1977) considers some species in the minor genera of the Ericaceae, and even some of the genera themselves, to be neo-endemic. Marloth (1929) and Goldblatt (1972), among others, have attributed this local endemism and disjunction partly to the diverse topography of the region, in which the concomitant diversity of soils and local climates, and the appearance of new land surfaces along the coast, gave opportunities for recent speciation, and partly to the great age of the flora, members of which may have been able to survive climatic changes by retreating into favourable localities.

Weimarck (1941), Levyns (1938, 1952), Dahlgren (1963), Williams (1972) and others have shown that typical families and genera of the Cape flora have a characteristic distribution pattern in which the highest numbers of species per area are concentrated in the western part of the region (see Fig. 1). Levyns (1952) went so far as to state it as a "rule that all genera of the Cape Flora show a concentration in the south-



Map 3. Concentration of *Aspalathus* species. The figures express the number of species represented in the area of each square. The map is based on dot maps of all the species. The distribution in Natal and the Khamiesberg area are excluded (cf. map 1). It is seen that the squares with the greatest concentration of species cover the mountain regions in the southwest. The number in the square covering most of the Cape Peninsula is surprisingly high considering the area occupied by the Cape Flats, which are poorer in species, and the sea. A high number of species is found in all the squares covering the western and southern mountain ranges. The great contrast between the relative richness in the Witteberg–Zwartberg mountains and the poverty of species in the Little Karoo deserts has only partly been possible to demonstrate.

FIG. 1.—Map 3 from Dahlgren (1963).

west. Any apparent constituent, which does not show this particular pattern of distribution, may be suspected of being an invader." The Restionaceae, Proteaceae and most of the Ericaceae show this pattern, as do the endemic families Bruniaceae and Penaeaceae and the larger genera *Cliffortia*, *Aspalathus*, *Phylla*, *Muraltia* and *Leucadendron*.

On the other hand, genera like *Babiana*, *Ferraria* and *Pteronia* that are fairly common in Capensis have their maximum concentration in Namaqualand. Among other "apparent constituents" that do not show the typical southwestern distribution are species of *Aloe*, *Erepsia*, *Carpobrotus*, *Crassula* and *Zygophyllum*. The presence of such species within the Cape flora and the presence of fynbos outliers on high mountains in Namaqualand as far north as Springbok suggest an intermingling of the Cape flora with those floras abutting it to the north.

In contrast, certain austral forest elements that also do not have the typical southwestern concentration occur within Capensis only as relic patches of forest vegetation in moist or sheltered habitats and not as constituents of fynbos. Such genera as *Podocarpus*, *Canonia*, *Platylophus* and *Curtisia* are examples of these (Levyns, 1962). Though their presence suggests a previous wider distribution of forest, there is little evidence that they are becoming adapted to the typical rigorous habitats occupied by fynbos.

The Cape flora also contains elements that are found more commonly in more distant lands. The grass *Hyparrhenia hirta* has a wide but disjunct distribution in the coastal Mediterranean, in east Africa and in southern Africa, linked only by high mountain outliers in the Sahara (Quézel, 1978). Genera such as *Anemone*, *Rubus*, *Scabiosa*, *Geranium* and *Dianthus* have their main centres of concentration in the northern hemisphere. *Aloe*, *Euphorbia* and the Asclepiadaceae are prominent members of other African floras. *Gladiolus* is widespread elsewhere in Africa and beyond. *Rhus* and *Euclea* have many more species in subtropical forest, scrub and savanna than in fynbos (Taylor, 1978). Similarities at the generic level suggest comparatively recent migrations and intermingling. Similarities at a higher taxonomic level suggest older affinities. Adamson (1958) considered that pairs of taxa like *Selaginaceae* (Cape) and *Globulariaceae* (Mediterranean), *Dimorphotheca* and *Calendula*, *Lobostemon* and *Echium*, *Crassula* and *Sedum*, and *Widdringtonia* and *Tetraclinis* provided evidence of a once widespread flora that became fragmented as the climate changed and then evolved in isolation.

The affinity of the Cape flora with that of southwestern Australia is striking but more remote than its affinities with northern hemisphere floras. The Thymelaeaceae, Haemodoraceae and Droseraceae are common to both continents and the endemic Cape family Roridulaceae is closely paralleled by the Australian Biblidaceae. Diosmae (Rutaceae) of the Cape has its counterpart in the Australian tribe Boroniae (Bolus & Wolley-Dod, 1904) and the genera *Tetraria* and *Gahnia*, and *Phylla* and *Cryptandra* are closely related (Adamson, 1958).

A picture emerges from this account of a present flora with high alpha and gamma diversities, a flora uniquely characterized by three widespread families and some endemic ones, and by many endemic taxa of lower rank, some young, some old, some widespread within the region, some restricted or disjunct in

distribution. The flora has a high concentration of species in the west, it shows some close taxonomic affinities with abutting floras and with the central African mountain flora, obvious but more distant affinities with the flora of southwestern Australia, and tenuous relationships with northern hemisphere floras. In all, the Cape flora is floristically and phytogeographically unique. Despite migrations and interminglings, it appears to have been isolated for a long time and to have suffered vicissitudes that have encouraged speciation, radiation and hybridization at a singularly high rate.

ORIGINS AND EVOLUTION OF FYNBOS

Such features suggest a long and varied history of geology and climate. On these grounds and because dominance by one or more species is a rare phenomenon in mature fynbos, the flora has hitherto been generally regarded as an ancient one (Marloth, 1915; Bews, 1925; Weimarck, 1941; Levyns, 1952; Adamson, 1958; Dyer, 1966). Yet despite general agreement on its age, there has been much controversy about the origin of the Cape flora. One school postulated an origin in the northern hemisphere, another in the southern, while yet a third contended that it originated somewhere in central Africa.

Until very recently the third theory has seemed most plausible, mainly as a result of the perceptive work of Levyns (1938, 1952, 1958, 1964), summarized by Van Vuuren (1973). She pointed out that very many members of the Cape flora, though they are concentrated in the Capensis region, show clear traces scattered throughout Africa, mainly on mountains as far north as Ethiopia. Proceeding southwards these "islands" become more frequent until, south of the Swartberg, all the scattered mountains of the Little Karoo have cappings of Cape plants while the flora of the lowlands is entirely different (Levyns, 1950). Levyns showed, too, that the more primitive members of Cape plants in many groups are to be found in mountain outliers within the tropics, whereas in the southwestern Cape many of the species are advanced and occupy restricted geographical ranges. These distribution patterns suggest that a flora of the Cape type was once widespread in central Africa, and that this flora retreated southward when the climate became unfavourable in the north, leaving traces on the northern mountains and speciating in the favourable temperate conditions found in the southwestern Cape.

This subject has been recently reviewed by Taylor (1978) who quoted further evidence suggesting that the presumed central African origin in fact represented a secondary centre of establishment for a flora that originated in austral lands. A review by Axelrod and Raven (1978), which appeared at the same time as Taylor's, presents evidence to support this theory. The evidence strongly suggests that the summer-dry climate is of recent origin in southern Africa and probably only appeared at the beginning of the Pleistocene some 2.5 million years ago. But already in the early Miocene, rapid speciation probably took place in South Africa with the broad warping and uplift of the continent. Further study of fossil floras like those of Coetzee (1978a, b) is needed to substantiate this. At about this time increasing glaciation in Antarctica brought the cold water of the Benguela Current to the west coast, accentuating the trend to increased summer drought on the western land surfaces. Then, when strengthening high pressure

systems brought this drier climate to the interior, sclerophyllous taxa that had lived earlier under summer and winter rain were adapting to increasingly dry summers. With dry summers spreading from the west, the taxa that required summer rain were gradually restricted eastward. This left the western environment open for the sclerophylls with tolerance to withstand summer drought, and many of those that survived in this new habitat had great opportunities for evolutionary radiation. This supports the findings of Levyns and others, mentioned earlier, that typical members of the Cape flora show a concentration of taxa and of endemics in the west.

But not all fynbos species originated in their present area. Axelrod & Raven (1978) postulate that even during the most recent climatic changes in the Pleistocene, fynbos in its present area may have been restricted by the expansion of forest and other vegetation, and could then have been displaced to the north, into the regions now occupied by desert and semi-desert. At the end of the Tertiary when the area of dry climate expanded, fynbos would have retreated to its present area and, during this retreat, interchange between fynbos and isolated pockets of relic sclerophyll vegetation may have contributed directly and through hybridization to the overall diversity of the flora. Thus, the rich flora of the present Capensis region "may represent but a remnant of a much richer sclerophyllous flora that ranged over the present desert and steppe areas into the Pleistocene" (*ibid.*, 1978).

Though Axelrod and Raven's hypothesis is attractive, the diversity and high rate of speciation in fynbos may not simply be the result of mass plant migrations following climatic change. As Levyns (1963) has pointed out, a vegetation category, like fynbos, is not "a flock of sheep" but an association of taxa that extend and diminish their ranges, not collectively but individually, in response to different factors to which the taxa are variously adapted. For example, the fact that fynbos is largely restricted to nutrient-poor soils would preclude its movement *en bloc* into the Karoo-Namaqualand area, even though individual taxa may adapt to the richer soils there.

The pulse of alternating cooler and warmer, and at times wetter, climates during the Quaternary would also have contributed to the high diversity in the Cape flora. At times of moister climate, some taxa of the sclerophyllous Cape flora could have spread widely over the present Karoo region and speciated there. "As drier climate returned, the flora shifted coastward into its present area, bringing new taxa with them and leaving relic stands in moist situations" (Axelrod & Raven, 1978, p.116). Thus, even during recent climatic changes in the Quaternary, the Cape flora may have been far more widespread (Levyns, 1938 in Axelrod & Raven, 1978), and has only been restricted to its present environment for a relatively short time.

An interesting feature in support of this view is that some Cape plants enter into a period of rapid vegetative growth towards the end of summer at a time when water supplies in the southwestern Cape are at their lowest. This strangely ill-adapted growth rhythm suggests that the ancestors of these plants "evolved in some place having a summer rainfall. The same phenomenon has been recorded for South Australia, where a similar change in climate is postulated to account for the same, apparently inexplicable, features of growth" (Levyns, 1964). This suggests that the

mediterranean climate is not ancient, but is so youthful that the plants have not yet fully adapted to it. Further research on South African plants is needed to clarify this phenomenon.

As stated earlier, a true mediterranean climate is present only in the western part of Capensis. It is this western part that was first colonized by primitive sclerophylls, and in the southwestern corner which has the highest rainfall and most diverse topography, speciation has been most active, producing the greatest concentration of taxa and endemics. This rich southwestern centre can be regarded as the true home of the Cape flora from whence it has radiated. To the north its spread is limited beyond Vanrhynsdorp by an arid climate, but eastward along the well-watered south coast it extends into the regions of non-seasonal and summer rain as far as Grahamstown. The eastern extension, having relatively low diversity and few endemics, is presumably younger than the western part. Fynbos would probably only have started colonizing this eastern area when the coastal temperate forest was reduced by a drying climate (cf. Acocks, 1975, Maps 1 & 2), but it has expanded its range faster within historic times owing to the destruction of forest by man (Von Breitenbach, 1972), and veld mismanagement is now encouraging its spread further eastward into mountain grassland (Trollope & Booysen, 1971).

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UITTREKSEL

'n Oorsig word gegee van vorige klassifikasies van die plantegroei van die Kaapse Floristiese Gebied of Capensis. Die onderskeidende kenmerke van die Kaapse flora, soos verskeidenheid van spesies, endemisme en verspreidingspatrone word bespreek in 'n poging om lig te werp op die oorsprong en evolusie van die vernameeste plantegroei-tipe van hierdie gebied wat vandag as fynbos bekend staan. Daar bestaan bewyse dat die huidige ryk Kaapse flora ontwikkel het in die suid-westelike deel van Capensis, 'n gebied met 'n egte Mediterreense klimaat.

REFERENCES

- ACOCKS, J. P. H., 1953. Veld types of South Africa. *Mem. bot. Surv. S.Afr.* No. 28.
- ACOCKS, J. P. H., 1975. Veld types of South Africa. 2nd ed. *Mem. bot. Surv. S.Afr.* No. 40.
- ADAMSON, R. S., 1938a. *The vegetation of South Africa*. London: British Empire Vegetation Committee.
- ADAMSON, R. S., 1938b. Notes on the vegetation of the Kamiesberg. *Mem. bot. Surv. S.Afr.* No. 18.
- ADAMSON, R. S., 1958. The Cape as an ancient African flora. *Pres. Add. Sect. K(Botany), Adv. Sci.* 15: 118-127.
- AXELROD, D. I. & RAVEN, P. H., 1978. Late Cretaceous and Tertiary vegetation history of Africa. In M. J. A. Werger, *Biogeography and ecology in Southern Africa* 1: 77-130. The Hague: Junk.
- BEWS, J. W., 1916. An account of the chief types of vegetation in South Africa, with notes on the plant succession. *J. Ecol.* 4: 129-159.
- BEWS, J. W., 1925. *Plant forms and their evolution in South Africa*. London: Longmans.
- BOLUS, H., 1886. Sketch of the flora of South Africa. In *Official Handbook of the Cape of Good Hope*. Cape Town.
- BOLUS, H., 1905. Sketch of the floral regions of South Africa. In *Science in South Africa* pp.199-240. Cape Town: Maskew Miller.

- BOLUS, H. & WOLLEY-DOD, A. H., 1904. A list of the flowering plants and ferns of the Cape Peninsula, with notes on some of the critical species. *Trans. S. Afr. Phil. Soc.* 14: 207-373.
- BOUGHEY, A. S., 1957. *The origin of the African flora*. Oxford: University Press.
- COETZEE, J. A., 1978a. Late Cainozoic palaeoenvironments of Southern Africa. In E. M. van Zinderen Bakker, *Antarctic glacial history and world palaeoenvironments* pp.115-127. Rotterdam: Balkema.
- COETZEE, J. A., 1978b. Climatic and biological changes in southwestern Africa during the Late Cainozoic. *Palaeoecology of Africa* 10/11: 13-29.
- DAHLGREN, R., 1963. Studies on *Aspalathus*. Phytogeographical aspects. *Bot. Notiser* 116: 431-472.
- DRÈGE, J. F. & MEYER, E., 1843. Zwei Pflanzengeographische Documente nebst einer Einleitung von Dr E. Meyer. *Besondere Beigabe zur 'Flora'*, 2.
- DRUDE, O., 1887. Atlas der Pflanzenverbreitung. In Berghaus, *Physik. Atlas*, Karte 6. Gotha.
- DRUDE, O., 1890. *Handbuch der Pflanzengeographie*. Stuttgart: Engelhorn.
- DYER, R. A., 1966. Impressions on the subject of the age and origin of the Cape Flora. *S. Afr. J. Sci.* 62: 187-190.
- EDWARDS, D., 1967. A plant ecological survey of the Tugela River Basin. *Mem. bot. Surv. S. Afr.* No. 36.
- ENGLER, A., 1882. *Versuch einer Entwicklungsgeschichte der extratropischen Florengebiete der südlichen Hemisphere*. Leipzig: Engelmann.
- GOLDBLATT, P., 1972. "Iridaceae" in Lectures on the Cape Flora at the University of Cape Town's Public Summer School, Jan-Feb. 1972.
- GOLDBLATT, P., 1978. An analysis of the flora of Southern Africa: its characteristics, relationships and origins. *Ann. Mo. bot. Gdn.* 65: 369-436.
- GOOD, R., 1974. *The geography of the flowering plants*. 4th ed. London: Longman.
- GRISEBACH, A., 1872. *Die Vegetation der Erde*. 2 vols. Leipzig: Engelmann.
- HEDBERG, O., 1965. Afroalpine flora elements. *Webbia* 19: 519-529.
- KILICK, D. J. B., 1963. An account of the plant ecology of the Cathedral Peak area of the Natal Drakensberg. *Mem. bot. Surv. S. Afr.* No. 34.
- KILICK, D. J. B., 1978. The Afro-alpine Region. In M. J. A. Werger, *Biogeography and ecology in Southern Africa* 1: 515-560. The Hague: Junk.
- KRUGER, F. J., 1977. Fynbos communities. In Council for the Habitat Conf. on Mountain Environments of S. Afr., Johannesburg, May 1976.
- LEVYNS, M. R., 1938. Some evidence bearing on the past history of the Cape Flora. *Trans. R. Soc. S. Afr.* 26: 401-424.
- LEVYNS, M. R., 1950. The relations of the Cape and Karoo floras near Ladismith, Cape. *Trans. R. Soc. S. Afr.* 32: 235-246.
- LEVYNS, M. R., 1952. Clues to the past in the Cape flora of today. *S. Afr. J. Sci.* 49: 155-164.
- LEVYNS, M. R., 1954. The genus *Muraltia*. *Jl S. Afr. Bot. Suppl.* 2.
- LEVYNS, M. R., 1958. The phytogeography of members of Proteaceae in Africa. *Jl S. Afr. Bot.* 24: 1-9.
- LEVYNS, M. R., 1962. Possible Antarctic elements in the South African flora. *S. Afr. J. Sci.* 58: 237-241.
- LEVYNS, M. R., 1963. The origins of the flora of South Africa. *Lantern* 13, 1: 17-21.
- LEVYNS, M. R., 1964. Migrations and origin of the Cape Flora. *Trans. R. Soc. S. Afr.* 37: 85-107.
- MARLOTH, R., 1906. The phytogeographical subdivisions of South Africa. *Rep. Brit. Assoc. Adv. Sci.* 1905: 589-590.
- MARLOTH, R., 1908. *Das Kapland*. Jena: Fischer.
- MARLOTH, R., 1915. The effects of drought and some other causes on the distribution of plants in the Cape region. *S. Afr. J. Sci.* 12: 383-390.
- MARLOTH, R., 1929. Remarks on the realm of the Cape flora. *S. Afr. J. Sci.* 26: 154-159.
- MCLARTY, R., 1952. Foreword. In C. A. Gardner, *Flora of Western Australia* 1. Perth: W. H. Wyatt.
- OLIVER, E. G. H., 1977. An analysis of the Cape flora. In *Proc. 2nd National Weeds Conf. of S. Afr.* pp. 1-18. Cape Town: Balkema.
- POLE-EVANS, I. B., 1936. A vegetation map of South Africa. *Mem. bot. Surv. S. Afr.* No. 15.
- QUÉZEL, P., 1978. Analysis of the flora of Mediterranean and Saharan Africa. *Ann. Mo. bot. Gdn.* 65: 479-534.
- REHMANN, A., 1880. Geobotanische Verhältnisse von Süd-Afrika. *Bot. Centralbl.* 1: 1119-1128.
- ROURKE, J. P., 1972. Taxonomic studies on *Leucospermum*. R. Br. *Jl S. Afr. Bot. Suppl.* 8.
- SCHIMPER, A. F. W., 1898. *Pflanzen-Geographie auf physiologischer Grundlage*. Jena: Fischer.
- SCHOUW, J. F., 1823. *Grundzüge einer allgemeinen Pflanzen-geographie und pflanzengeographischer Atlas*. Berlin: Reimer.
- TAKHTAJAN, A., 1969. *Flowering plants: origin and dispersal*. Edinburgh: Oliver & Boyd.
- TAYLOR, H. C., 1972. Fynbos. *Veld & Flora* 2: 68-75.
- TAYLOR, H. C., 1978. Capensis. In M. J. A. Werger, *Biogeography and ecology in Southern Africa* 1: 171-229. The Hague: Junk.
- TROLLOPE, W. S. W. & BOOYSEN, P. DE V., 1971. The eradication of macchia (fynbos) vegetation on the Amatole Mountains of the Eastern Cape. *Proc. Grassld. Soc. Sth. Afr.* 6: 28-38.
- VAN VUUREN, D. R. J., 1973. Die oorsprong en verwantskappe van die Suid-Afrikaanse flora. *Publ. v.d. Univ. v.d. Noorde*, Reeks C, No. 25.
- VON BREITENBACH, F., 1972. Indigenous forests of the Southern Cape. *J. bot. Soc. S. Afr.* 58: 18-47.
- WEIMARCK, H., 1941. Phytogeographical groups, centres, and intervals within the Cape Flora. *Lund. Univ. Arsskrift Avd. 2*. Bd. 37 Nr. 5.
- WERGER, M. J. A., 1978a. The Karoo-Namib Region. In M. J. A. Werger, *Biogeography and ecology of Southern Africa* 1: 231-299. The Hague: Junk.
- WERGER, M. J. A., 1978b. Biogeographical division of Southern Africa. In M. J. A. Werger, *Biogeography and ecology in Southern Africa* 1: 145-170. The Hague: Junk.
- WERGER, M. J. A. & COETZEE, B. J., 1978. The Sudano-Zambezian Region. In M. J. A. Werger, *Biogeography and ecology in Southern Africa* 1: 301-462. The Hague: Junk.
- WHITE, F., 1978. The Afromontane Region. In M. J. A. Werger, *Biogeography and ecology in Southern Africa* 1: 463-513. The Hague: Junk.
- WHITTAKER, R. H., 1972. Evolution and measurement of species diversity. *Taxon* 21: 213-251.
- WILD, H., 1968. Phytogeography in South Central Africa. *Kirkia* 6: 197-222.
- WILLIAMS, I. M. J., 1972. A revision of the genus *Leucadendron* (Proteaceae). *Contr. Bolus Herb.* 3: 1-425.

Miscellaneous ecological notes

VARIOUS AUTHORS

NOTES ON THE USE OF THE TERM "RENOSTERVELD"

These notes have been compiled to clarify and standardize botanical reference to the vegetation referred to as Rhenosters bosch (Van der Stel in Waterhouse, 1932), Rhenosterveld (Marloth, 1908; Bews, 1916; Levyns, 1929, 1935 & 1972; Acocks, 1933, 1953 & 1975), Rhenoster-veld (Adamson, 1938), Renosterbosveld (Jordaan, 1946; Acocks, 1953 & 1975), Rhenosterbosveld (Acocks, 1953 & 1975) and Renosterveld (Smith, 1966; Taylor, 1978).

In 1685, Simon van der Stel found that the Olifants River Valley "... is bewassen met Rhenosters bosch alhier so genaemt om dat de selve daer gemeenlyck in legeren, ..." (Waterhouse, 1932). This passage has been translated by Waterhouse (1932) as: "The above-mentioned valley is overgrown with rhinoceros wood, so-called here because these animals are usually found in it." This is therefore the first reference to the vernacular name for "renosterveld". The unit "bosch" having been replaced by "veld" and the Afrikaans spelling "renoster" for the rhinoceros having been introduced.

Levyns (1972), in contrast, suggests that the grey, uneven appearance of a "rhenosterveld" community, when viewed from a distance, resembles the wrinkled hide of the rhinoceros.

Although the vernacular name "renosterbos", for the plant, *Elytropappus rhinocerotis*, is an undisputed fact, Smith (1966) has wrongly referred to the above passage in Van der Stel's journal as the first use of this name for the plant, while Van der Stel was, in fact referring to the vegetation unit. Smith, quoting Waterhouse (1932), has wrongly spelt "Rhenosters bosch" as "Rinocerbosch" (sic).

The recent tendency to refer to this vegetation as "rhenosterbosveld" or "renosterbosveld" might result from *E. rhinocerotis* often becoming dominant following disturbance of the vegetation. The absence of any rhinoceros (*Diceros bicornis*), through their extinction in this habitat, may be a contributing factor to emphasis being placed on the renosterbos plant instead of on the rhinoceros itself. Acocks (1975), however, uses the terms "rhenosterveld" and "rhenosterbosveld" indiscriminately.

The term "renosterbosveld" could be misconstrued as "renoster-bosveld". Bushveld or "boschveld", the parklands of the northern Transvaal (Carpenter, 1938), are absent in the Cape Province.

It is proposed here that the original and most widely used concept be retained using the correct Afrikaans spelling "renosterveld".

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REFERENCES

- ACOCKS, J. P. H., 1933. *Vegetation of a portion of the Cape Flats and a list of the plants so far found there*. Unpubl. M.Sc. thesis, Univ. Cape Town.
- ACOCKS, J. P. H., 1953. Veld types of South Africa. *Mem. bot. Surv. S. Afr.* 28: 1-192.
- ACOCKS, J. P. H., 1975. Veld types of South Africa. *Mem. bot. Surv. S. Afr.* 40: 1-128.
- ADAMSON, R. S., 1938. *The vegetation of South Africa*. London: British Empire Vegetation Committee.
- BEWS, J. W., 1916. An account of the chief types of vegetation in South Africa with notes on plant succession. *J. Ecol.* 4: 129-159.
- CARPENTER, J. R., 1938. *An ecological glossary*. New York: Hafner.
- JORDAAN, P. G., 1946. Plantegroei van die distrikte Bredasdorp en Caledon. *Tydskr. Wetensk. en Kuns*, nuwe reeks 6: 47-58.
- LEVYNS, M. R., 1929. The problem of the rhenoster bush. *S. Afr. J. Sci.* 26: 166-169.
- LEVYNS, M. R., 1935. A revision of *Elytropappus* Cass. *Jl S. Afr. Bot.* 1: 161-170.
- LEVYNS, M. R., 1972. The rhenosterbush. *Veld & Flora* 2 (1): 7-9.
- MARLOTH, R., 1908. *Das Kapland*. Jena: Gustav Fischer Verlag.
- SMITH, C. A., 1966. Common names of South African plants. *Mem. bot. Surv. S. Afr.* 35: 1-642.
- TAYLOR, H. C., 1978. Capensis. In M. J. A. Werger, *The biogeography and ecology of southern Africa*. The Hague: Junk.
- WATERHOUSE, G., 1932. *Simon van der Stel's journal of his expedition to Namaqualand 1685-6*. Dublin: Longmans, Green.

C. BOUCHER

OBITUARIES

JOHN PHILLIP HARISON ACOCKS (1911–1979)

John Acocks (originally Acock) was born in Cape Town on 7th April 1911 (Fig. 1). He received most of his schooling at the South African College School (SACS) and then entered the University of Cape Town, where he graduated with B.A. & B.Sc. in 1932, majoring in Botany, Physics, Chemistry and Latin. In botany he studied under Professors R. S. Adamson, R. H. Compton, Dr M. R. B. Levyns and Miss E. L. Stephens. In 1933 he was awarded the M.Sc. degree for a thesis entitled "Vegetation of portion of the Cape Flats". Subsequently he worked for two years towards a Ph.D. degree on the effect of burning, resting, clearing and cultivation of the humid fynbos of Kirstenbosch and the more arid fynbos of Tierbos, Hout Bay. This work was undertaken at the instigation of Dr I. B. Pole Evans, then head of the Division of Plant Industry, who was looking around for suitable pasture research officers. Owing to lack of essential apparatus apparently not supplied in time by the Department of Agriculture, Acocks was unable to finish his project. It was about this time that Acocks (letter to Mr L. S. Richfield of 1976–12–03), while looking at fynbos on Sir Lowry's Pass, observed that there "were a lot of species that one already knew at sight with certainty, there were a lot more in collectable condition and the remainder would sooner or later become collectable. Eventually one would know them all and would simply list them, collecting specimens only when in doubt." Thus was evolved his well-known listing method of plant survey.

In January 1936 Acocks joined the Division of Plant Industry in Pretoria and worked under Dr

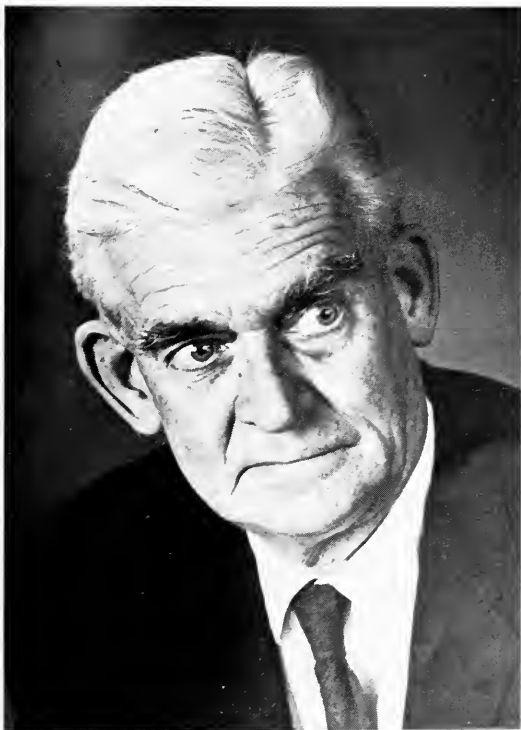


FIG. 1.—Mr J. P. H. Acocks.

J. W. Rowland. Within a few months he was sent to Kimberley to make a survey of the Griqualand West area (Fig. 2) in connection with the vermeerbos problem and to establish a research station there. He chose a suitable site for a research station (at Koopmansfontein), but was relieved of the task of establishing it. Based at the McGregor Museum in Kimberley, Acocks carried on with his survey of vermeerbos and took the opportunity of applying his listing method. He widened his horizons by surveys of farms in other parts e.g. Carnarvon, Petrusburg and Middelburg, Cape. He had a break of four months when he was assigned to the Swedish plant collector, Adolf Häfstrom; from 17th September–15th November 1938 they undertook a plant collecting expedition "by devious routes from Cape Town to Victoria Falls and back", travelling in an enormous black Chrysler sedan (Fig. 3). The joint collection amounted to 2 340 specimens.

In 1939 Acocks returned to Pretoria, where he became involved in the botanical analysis of pastures, at Rietvlei Pasture Research Station just outside Pretoria and Leeuwkuil Pasture Research Station near Vereeniging. He applied his estimated frequency listing method and devised two new methods of pasture analysis, namely the ring and rod method (Fig. 4) and the basal cover calipers method, all of which were significant enough to be fully described in the Commonwealth Agricultural Bureaux Bulletin No. 42 (1954). He studied the vegetation of the Kakamas Veld Reserve in the northern Cape and accompanied Dr Pole Evans and others on several trips to the Transvaal Bushveld to take photographs illustrating good and bad farming practices.

During 1941–1942 he was stationed at Towoomba Pasture Research Station near Warmbaths. There he made detailed surveys of the pastures on the station involving four or five successive stages in 16 veld types and sub-types (see Diagram 1, p. 2 in Veld Types of South Africa, 1975.). Together with Mr L. O. F. Irvine O/C of the Station, he travelled widely in the northern Transvaal examining the effects of various grazing systems on pastures. At this time Acocks contributed to Professor J. M. Hector's "premature" attempt to compile a detailed vegetation map of South Africa to replace the rather oversimplified vegetation map produced by Pole Evans in 1935. However, as Acocks pointed out (letter to author, 1969–02–26), "we found we could distinguish 140 vegetation types, but none of us concerned with it could draw the boundaries except in the few regions we happened to know well, e.g. parts of the Transvaal in the case of Hector, Irvine and others, Natal in the case of Pentz, and Griqualand West in the case of myself. This meant that somebody would have to undertake a survey of most of the country, and he (Hector) wanted the Department to second me to him to do the job."

In 1942 Acocks was based at Dohne Research Station near Stutterheim in the eastern Cape, where he carried out point quadrat analyses of pastures and collected generally in the region.

1943 saw Acocks at Estcourt Pasture Research Station in Natal. As on the previous stations, he was occupied with botanical analyses of pastures. In addition, he did much collecting and most important of all, conceived the idea of the veld type. To quote Acocks (letter to author, *l.c.*), "The idea of the Veld

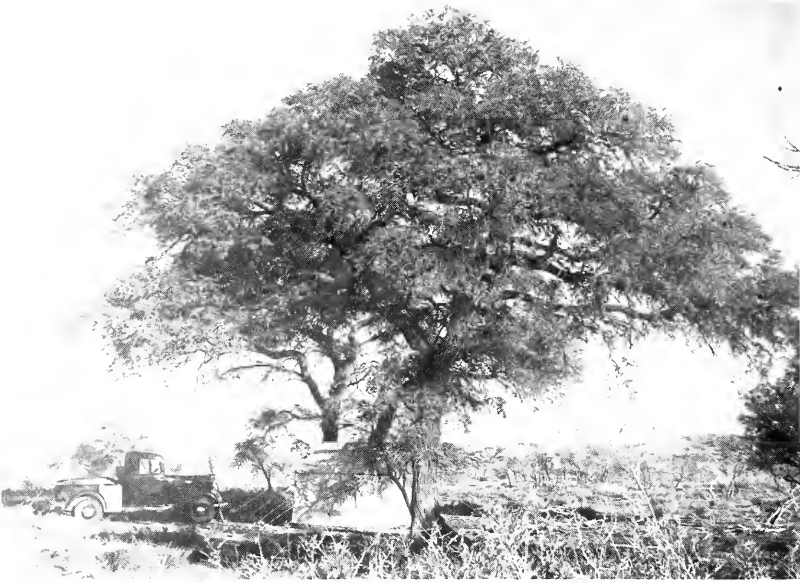


FIG. 2.—Acocks's camp under *Acacia erioloba* at Witsand, south-west of Postmasburg in Griqualand West.



FIG. 3.—The two Swedish collectors, Adolf Häfstrom & Erik Wahl, who Acocks joined on an expedition from Cape Town to the Victoria Falls in 1938. Photograph taken at Buisvlei north-west of Prieska.



FIG. 4.—The ring and rod method of pasture analysis being used in the Kakamas Veld Reserve (1939).

Type was developed, while I was stationed at Estcourt, under the influence of Pentz with his idea that the vegetation, being an indicator of the whole ecological environment, is also an indicator of correct land use." Acocks defined the veld type as "a unit of vegetation whose range of variation is small enough to permit the whole of it to have the same farming potential." In July 1945, while still at Estcourt, Acocks was transferred to the newly-created Botanical Survey Section of the Division of Botany and Plant Pathology. Largely at his own insistence, he was given the huge task of preparing a comprehensive vegetation map of South Africa which, according to Acocks (letter to M. Richfield, *l.c.*), "was what all the previous work appeared to be calculated to lead up to."

Acocks remained at Estcourt and surveyed the eastern part of the country. In the survey Acocks employed his relative abundance listing method and used as his unit of vegetation, the veld type. In 1948 the western part had to be surveyed "in less detail as the need for the map became more urgent", and consequently Acocks was transferred to Middelburg in the Cape, where he was based at Grootfontein College of Agriculture. In 1948 and 1949 Acocks travelled all over the country as a member of the Desert Invasion Committee.

Acocks's mapping method proved so successful that within eight years he had sufficient data to prepare a vegetation map and accompanying text, which was published as "Veld types of South Africa, *Mem. bot. Surv. S. Afr.* No. 28, 192 pp. (1953). An accomplished artist, Acocks did all the colour work of the original map. During his survey Acocks examined 1533 stands and collected over 25 000 specimens (i.e. numbers). In "Veld types" Acocks recognized 70 veld types and 75 variations. These were described in varying detail,

the veld types in the eastern half of South Africa (as explained earlier), receiving greater attention than those in the western half. Considerable accent was placed on the spread of Karoo as a result of incorrect veld management. Included in the memoir was a series of maps showing the vegetation of South Africa in AD 1400, 1950, 2050? (showing the possible spread of karoo eastwards almost as far as Vereeniging and of desert almost to Bloemfontein) and a map showing what the vegetation would be like if scientifically managed. The memoir was updated in 1975, the second edition containing 104 photographs illustrating the veld types. "Veld types of South Africa" is a classic work in the field of South African botany and the information contained therein has been used by scientists of many disciplines. The map has stood the test of time and even after 26 years does not require radical revision. The map has been described by some as essentially a land use map and this is one of the reasons for its great value.

Since 1953 Acocks attempted to equalize his treatments of the veld types. He concentrated chiefly on the karoo and karroid types and had examined an additional 2467 stands involving some 177 000 species records (Figs 5, 6 & 7). The revision of these veld types will be published in the Institute's journals.

During the course of his survey, Acocks collected over 25 000 numbers of beautifully pressed specimens (with the labels written in his copper-plate handwriting), which have enriched herbaria both here and overseas. At the same time he added much to our knowledge of the South African flora (Fig. 8): many new species were discovered and new distribution records made. Acocks had an exceptionally good "eye" for plants and was able to recognize plant species in all their various growth and ecological forms. He often corrected herbarium identifications and was frequently consulted by taxonomists with problems concerning species limits.

Acocks amassed a tremendous amount of data on plant distribution and frequency and this is all meticulously indexed on cards. The Department of Agricultural Technical Services considered his data so valuable, that all his field note books were micro-filmed several years ago. The possibility of computerizing his data is being explored.

Apart from botanical work, Acocks played a significant rôle in pasture science in South Africa. Mention has already been made of his contributions to pasture analysis. As early as 1945 Acocks came to the conclusion that what the veld needed was non-selective grazing with short, heavy grazing followed by long rests. This, he felt, would help to restore the climax vegetation in many parts of the country. After the publication of "Veld types", he was able to devote more time to the subject and eventually in 1965 he formulated his principle of non-selective grazing (NSG) which formed the basis of the Acocks-Howell method of grazing management. A document setting out Acocks's views in detail was sent to all pasture research workers in South Africa in August 1965 and comments were invited. Pasture scientists, on the whole, opposed the method, some suggesting that there was nothing new in the method while others doubted that it would work in all types of grassland. The extra cost of fencing and provision of watering points was also mentioned. However, a considerable number of farmers, particularly in the Karoo, supported the method, some even testing it and refining it and achieving apparently successful results. The method received considerable publicity and was even

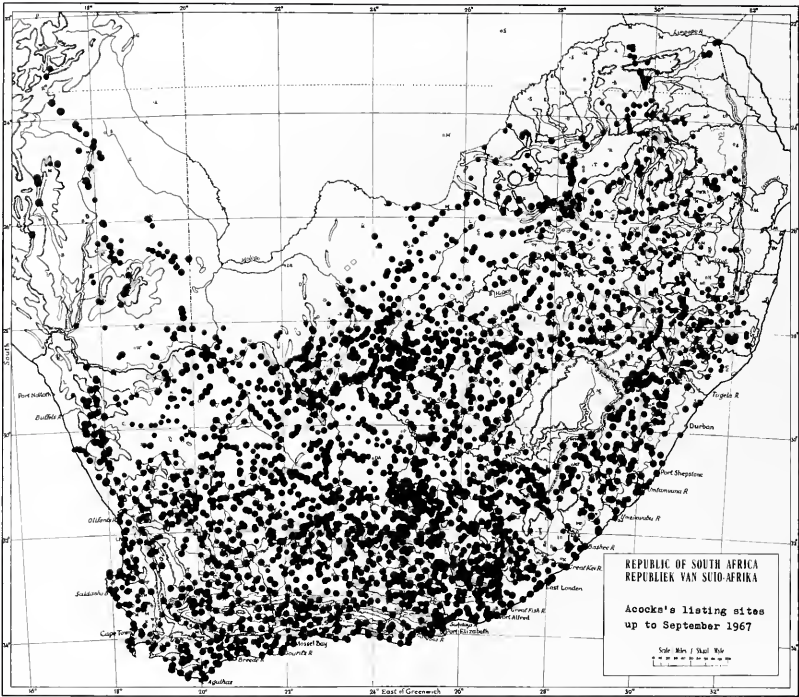


FIG. 5.—Map showing Acocks' listing sites up to September 1967.

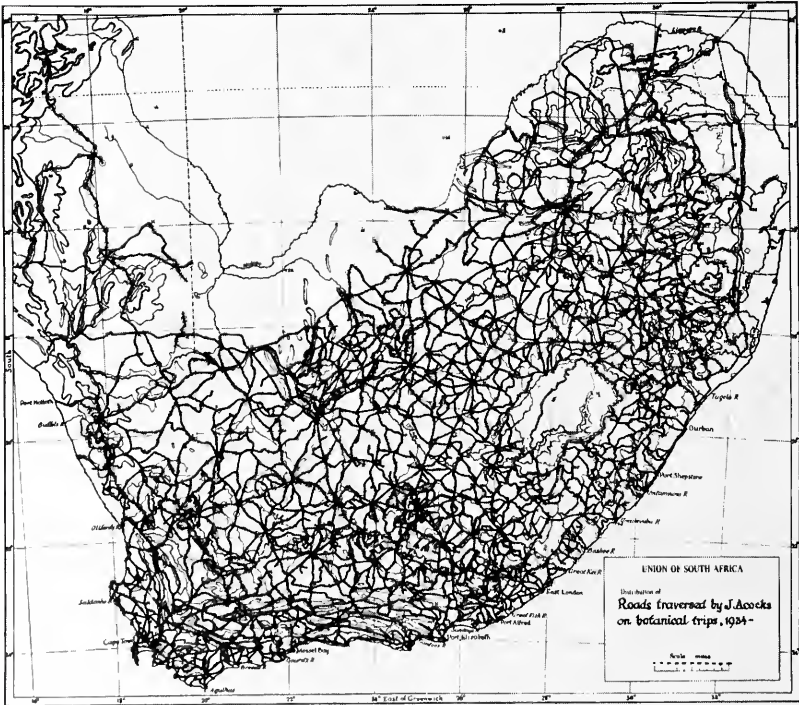


FIG. 6.—Map showing roads traversed by Acocks from 1934-1965.

FIG. 7.—Acocks listing plants in Coastal Macchia at Danger Point in 1962.



FIG. 8.—Acocks viewing *Aloe falcata* in Namaqualand in 1963.



exported, modified and applied with success in Zimbabwe. The well-known wagon-wheel method of grazing management devised by the Zimbabwe ecologist, Alan Savory, is derived from the Acocks-Howell method. It is true to say that the Acocks-Howell method, while to-day not generally accepted in its original form, led to the acceptance of the feasibility of multi-camp systems; it led to the reappraisal of existing systems of grazing management and provided a stimulus to the development of new systems.

Acocks retired from the Department of Agricultural Technical Services in April 1976, but was re-employed to complete his revision of "Veld types of South Africa".

Mention must be made of Acocks's guidance to a long line of ecologists at the Botanical Research Institute and elsewhere. He gave freely of his knowledge and experience and this has benefited South African ecology immensely.

Acocks did not receive the recognition he deserved, partly because he was stationed in Middelburg in the Cape, far from the main scientific centres and partly because he was by nature, a quiet, solitary and individualistic worker. He repeatedly refused promotion, because he wished to carry on with research.

Acocks's publications, though few (list appended) represent extremely valuable contributions to South African botany, especially "Veld types of South Africa". Clearly reflected in Acocks's papers were his chief attributes as a scientist, namely a capacity for painstaking collection and synthesis of data and a capacity for original thinking.

Honours came to Acocks in his twilight years. In 1975 he was awarded a gold medal by the Fertilizer Society of South Africa for his outstanding contributions to agriculture. In 1976 he was awarded three medals: the medal of the Wildlife Society of Southern Africa for notable contributions to conservation; the

South African Medal for Botany awarded by the South African Association of Botanists and the Senior Captain Scott Memorial Medal by the South African Biological Society for outstanding scientific research.

Acocks died at Middelburg in the Cape on 20th May 1979.

In conclusion, I would like to quote Dr R. A. Dyer, one of his previous directors, who wrote: "In his specialized field of plant geography, Acocks is without peer amongst botanists both past and present". We salute a brilliant botanist and a good friend.

PUBLICATIONS

- ACOCKS, J. P. H., 1952. The grassy veld types of South Africa. In *Veld Gold*, Report of the Southern African Grass Conference, September 1952. 22–29. Johannesburg: National Veld Trust.
- ACOCKS, J. P. H., 1953. Veld types of South Africa. *Mem. bot. Surv. S. Afr.* No. 28, 192 pp.
- ACOCKS, J. P. H., 1966. Agriculture in relation to a changing vegetation. *S. Afr. J. Sci.* 52: 101–108.
- ACOCKS, J. P. H., 1964. Karoo vegetation in relation to the development of deserts. In D. H. S. Davis, *Ecological studies in Southern Africa*. 100–112. The Hague: W. Junk.
- ACOCKS, J. P. H., 1966. Non-selective grazing as a means of veld reclamation. *Proc. Grassld Soc. Sth. Afr.* 1: 33–39.
- ACOCKS, J. P. H., 1967. Vegetation of South Africa. *Lantern* 16: 50–56.
- ACOCKS, J. P. H., 1971. The distribution of certain ecologically important grasses in South Africa. *Mitt. bot. StSamml., Münch.* 10: 149–160.
- ACOCKS, J. P. H., 1975. Veld types of South Africa. 2nd ed. *Mem. bot. Surv. S. Afr.* No. 40, 128 pp.
- ACOCKS, J. P. H., 1976. Riverine vegetation of the semi-arid and arid regions of South Africa. *Jl S. Afr. biol. Soc.* 17: 21–35.
- ACOCKS, J. P. H., 1979. The flora that matched the fauna. *Bothalia* 12: 673–709.

D. J. B. KILLICK

ADOLF JOSEPH WILHELM BAYER (1900–1978)

Born at Hermannsburg, Natal, on the 8th January 1900, Adolf Bayer, except for vacations and a study tour in America, spent his life in the province of his birth. His school days were at Durban Boy's High and his university career was completed at the then Natal University College, Pietermaritzburg. He majored in botany and obtained his D.Sc. degree under the world renowned plant ecologist, J. W. Bews. He was appointed lecturer under Bews in 1925 and in 1939 succeeded him in the professorial chair, which he occupied with distinction until his retirement in 1967. At this juncture, he was awarded the title of Emeritus Professor of Botany.

It was not surprising that Adolf Bayer's scientific leaning was to plant ecology to which aspect of botany he specialized as a background for his well-illustrated university lectures. In addition to his professorial duties, he served on the Senate and University Council and performed the duties of Dean of the Faculty of Science on several occasions. In 1970 he was appointed acting Vice Principal of the University of Natal in Pietermaritzburg and awarded the degree of Doctor of Science Honoris Causa.

Apart from his strictly university duties, Adolf Bayer (Fig. 9) took an active part in the affairs of a number of outside societies, served on numerous commissions and many advisory bodies. He was Sectional President of the South African Association for the Advancement of Science ($S_2 A_3$) in 1942 when he delivered an address on "Thornveld trees (Natal): a note on plant adaptation", and was President of the



FIG. 9.—Professor A. W. Bayer.

Society in 1971, when his address was entitled, "Aspects of Natal's botanical history."

In recognition of his contributions to botanical science he was elected a Fellow of the Royal Society of South Africa and Volume 36 (1970) of the *Journal of South African Botany* was dedicated to him in eulogistic terms.

It has been said of Adolf Bayer that in spite of his personal contributions to science he preferred to be recognized for the many distinctions gained by his students. The Botanical Research Instituted has over the years boasted a strong contingent of staff who qualified under his tutelage.

As a contemporary student, lifelong colleague in botanical science and personal friend, I can testify to his unassuming kindly nature, staunchness, dedication and absolute integrity. In these times when old age often presents social problems, one cannot mourn the peaceful passing of one who has had a long and fruitful life to the end. In a letter written in the week of his death he wrote: "Daphne and I have had a better year healthwise than any since 1973. I have finished my contribution to the book on Katharine Saunders's flower paintings and the printer hopes to send proofs during the month. Anyway I can relax awhile. Yours Adolf."

He died at his home in Kloof on Friday, 8th December 1978.

R. A. DYER

ROBERT HAROLD COMPTON (1886–1979)

Professor R. H. Compton, former Director of the National Botanic Gardens, Kirstenbosch, died in his 92nd year in Cape Town on 11 July 1979 after a career devoted almost entirely to studying the South African flora (Fig. 10).



FIG. 10.—Professor R. H. Compton.

He was born at Tewkesbury, Gloucestershire, on 6 August 1886 and was educated at Mill Hill School, London, entering Gonville and Caius College, Cambridge in 1905. In 1909 he graduated with a double first class and distinction in botany, later taking the M.A. degree. From 1911–13 he was Demonstrator in Botany at Cambridge University and during 1914 participated in a field expedition to New Caledonia, collecting about 2 500 specimens of the rich flora, including new genera and a number of new species. In 1915 he married Kathleen Askin Sealy of Sydney, Australia, and they had two children, a daughter and a son.

After some years of war service from 1915–18, he came to South Africa in March 1919 to become Director of the National Botanic Gardens at Kirstenbosch and Harold Pearson Professor of Botany at the University of Cape Town, posts which he held for the next 34 years. While at Cambridge his main contributions to botanical literature dealt

with anatomy and morphology of Gymnosperms, Pteridophytes and Angiosperm seedlings but, from his arrival in South Africa, his interests turned to the taxonomy of the South African flora. Most of his papers were published in the *Journal of South African Botany* which he initiated in 1935 and edited until his retirement.

In 1921 he established the first subsidiary garden of the National Botanic Gardens when he acquired a site at Whitehill near Matjiesfontein to cater for the rich succulent flora and, in 1931, he published a paper on the flora of the Whitehill District in *Trans. Roy. Soc. S. Afr.* 19: 269–329 in which two new genera and many new species were described. In 1945 the Karoo Garden was moved to a more convenient location near Worcester. He collaborated with the artist Elsie Garrett Rice in her production of *Wild Flowers of the Cape of Good Hope*, Cape Town, 1951, and in 1965 published a history of the first 50 years of the National Botanic Gardens under the title *Kirstenbosch, Garden for a Nation*.

On his retirement in 1953 he settled in Swaziland and, at the request of the Swaziland Government, supported by the British Colonial Development and Welfare Fund, he undertook a botanical survey of the territory. Preliminary results were published as "An annotated checklist of the flora of Swaziland" in *Jl S. Afr. Bot. Suppl.* 6 (1966). After his return to Cape Town in 1971, he enlarged this to a full scale "Flora of Swaziland" which appeared as *Jl S. Afr. Bot. Suppl.* 11 (1976) on his 90th birthday.

Many honours were conferred upon him. He was elected F.R.S.S. Afr.; was President of the S. African Association for the Advancement of Science in 1957 and received their medal and grant; an Honorary fellow and medalist of the Royal Horticultural Society; twice President of the South African Museums Association; President of the Mountain Club of South Africa for eleven years and was awarded an honorary D.Sc. by the University of Cape Town in 1968.

He was one of the most prolific collectors in South Africa, his numbers exceeding 35 000, of which about 8 000 were collected in Swaziland. As may be expected, these contained many novelties and two genera are named after him: *Comptonella* Bak. f. from New Caledonia and *Comptonanthus* B. Nord. from South Africa. In addition, he is commemorated in the names of about 20 species. When it was decided to remove the Bolus Herbarium from Kirstenbosch to the University of Cape Town in 1938, he vigorously set about building up a new herbarium at Kirstenbosch which, appropriately, is named the Compton Herbarium in his honour.

L. E. CODD

REVIEW OF THE WORK OF THE BOTANICAL RESEARCH INSTITUTE, 1978/1979

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INTRODUCTION

Progress with botanical research has been good and the rate of publication has been maintained at a high level, a usually reliable indication of the state of field. The steady increase of the volume of material submitted for publication in the botanical journals of the Institute has made it necessary to investigate alternative methods of publication and funding to offset the steep rise in costs.

The need for more research in the plant-taxonomic and ecological fields is becoming increasingly evident and pressures building up will require a positive response in addition to the efforts already being made by the Department. The real awareness of environmental problems and their vital importance to man, which already exists and is growing, will make a large input into biological research, especially plants, unavoidable in the near future. Nevertheless, the contributions to both the fields mentioned, as is evident from this report, have been considerable.

The control of weeds particularly from a pasture point of view will require careful research planning as well as increased efforts to control, in order to deal with a potentially dangerous situation. In this respect, nassella tussock, australian acacias as well

as jointed cactus and other members of this family, are examples of what can happen if weeds are allowed to get out of hand. Research on botanical aspects of weeds have therefore been regarded as of high priority. Amongst other activities, the compilation of a national weed list, which is now complete, is the first step towards monitoring weeds and establishing the status of potentially harmful plants with a view to control before the exponential stage of distribution expansion is reached.

The use of electronic devices and computers in research and information services is a fast expanding activity. The vast and complicated data bank for herbarium type information is now, after several years of activity, nearing the productive stage. It will provide a strong stimulus for types of research, which, without this facility, would not have been possible, such as the large-scale production of distribution maps and check lists of a range of geographical areas.

The trend towards the integration of botanical research into environmental planning and development of the country has been maintained but, as said earlier, research will have to be expanded to keep pace with the demand for information.

REPORTS OF THE SECTIONS

HERBARIUM SERVICES SECTION

The five herbaria of the Institute continued to identify plants and provide information for a wide range of people including officers of the Institute, various State and Provincial Departments, universities and the public both in South Africa and neighbouring countries.

National Herbarium, Pretoria (PRE)

A total of 17 575 specimens was named and 766 visitors dealt with. Accessions to the herbarium numbered 26 571. During the year 8 300 specimens were sent out on loan to local and overseas researchers.

A few minor expeditions were undertaken to the eastern Transvaal. The main expedition was organised in conjunction with Prof. H.-D. Ihlenfeldt and Dr H. Hartman of Hamburg. Originally it has been intended to mount a major expedition to the southern Namib Desert in the area between Lüderitz and the Orange River; as a result of the poor rains only Messrs D. S. Hardy and S. Venter went from the Institute.

The repackaging of the moss collection has been completed and a start has been made on the liverworts. When these have been completed, the lichen collection will be tackled. The move to the new cryptogamic herbarium in the basement will take place during September 1979. It is hoped that the Herbarium will obtain the services of a lichenologist.

A new herbarium procedure was introduced with the establishment of a service room in the basement. This has centralized such activities as the receipt and dispatch of specimens for identification, loans, exchanges and the preparation of herbarium labels.

On December 6th the Director and Mr E. G. H. Oliver attended the official opening of the Venda Herbarium at Tate Vondo in the eastern Soutpansberg in the Venda Homeland. The opening was performed by the Venda Minister of Agriculture and Forestry and attended by the Chief Minister and remainder of the Cabinet.

Among the numerous visitors who came to consult the collections and staff were the following: Prof. H.-D. Ihlenfeldt and Dr H. Hartman (Hamburg), Dr Juliet Prior (London: Swaziland Archeological Association), Prof. D. and Dr U. Müller-Doblies (Berlin), Mr R. B. Drummond and Mr L. C. Leach (Salisbury), Dr O. J. Hansen (UNDP, Botswana) and Dr H. van Gils (Botswana).

Wing A: Mr P. J. Vorster left the Institute in February to take up a post in the University of Stellenbosch. He completed his work on *Mariscus* for which he obtained his doctorate. Mrs E. van Hoepen took over control of this Wing.

Miss Smook continues with work on grasses and will assist Dr E. G. Gibbs-Russell with the treatment of grasses for the Flora.

Miss C. Reid began in February and is concentrating on petaloid monocots.

Dr R. E. Magill produced a check list of the mosses (591 spp.) and liverworts (316 spp.) for southern Africa and is continuing with revisions for the Flora. His assistant Mr J. van Rooy is dealing with most identifications and is working on *Bryum*.

Wing B: Mr T. H. Arnold left the Herbarium in November on transfer to the Economic Botany Section. He completed the curating and updating of the Cyperaceae resulting from his investigations at Kew.

Mr G. Germishuizen resumed charge of the Wing and has now taken up Polygonaceae for his research project. He has also been working on the botanical text for a book on medicinal and edible plants.

Mr D. A. Davies joined the staff in January and has been doing general naming and curating.

Wing C: Miss E. Retief has begun with a study of the Campanulaceae of Southern Africa. She delivered a paper on seed collections at the Annual Congress of the South African Association of Botanists in Stellenbosch.

Mr P. P. J. Herman joined the staff in March. He had already begun doing an M.Sc. degree on the anatomy of *Pavetta*.

Mrs M. Crosby moved to this Wing in January to assist with general identifications. Mrs J. L. M. Grobler also moved back to this Wing as a result of Miss M. Evans having left in February. Mr S. Venter left in February to resume his studies.

Mr C. Hildyard has decided to take up botany as a career and is studying at the University of Pretoria. He is employed on a part-time basis.

Wing D: Miss W. G. Welman continues to be responsible for the Wing. She has recently taken over as South African extractor for *Excerpta Botanica*.

Mrs S. Smithies gained her M.Sc. degree with distinction at the Witwatersrand University with a thesis entitled 'Studies in the Middle Ecca (Lower Permian) Flora from Hammanskraal, Transvaal, with emphasis on the Glossopterid fructification *Ottokaria Zeiller*'.

Mr G. Goosen joined the staff in February and will be going to university next year to do a B.Sc. degree.

Service Room: Mrs I. Ebersohn began in January and Mrs G. L. Radmacher in July 1979. The work in the Service Room is controlled by Mrs E. van Hoepen.

Natal Herbarium, Durban (NH)

A total of 1 459 specimens was named and 414 visitors dealt with. Accessions to the herbarium numbered 3 167.

Mr P. C. V. du Toit is continuing with his work on *Pentastichis* (Poaceae). Mrs H. M. A. du Toit left the staff last year and her place was taken in February by Mrs B. J. Pienaar who worked for the first six months in the National Herbarium in Pretoria gaining experience. Miss A. Wright took over as technical assistant from Miss A. M. King who left in October.

Prof. K. Schlosser of Kiel, West Germany, again visited the Herbarium in connection with his work on trees and associated folklore.

Albany Museum Herbarium, Grahamstown (GRA)

A total of 2 528 specimens was named and 598 visitors dealt with. Accessions to the herbarium numbered 1 181.

Mrs E. Brink continues as Curator of the Herbarium. Miss G. V. Britten was transferred to the half-day post after serving for 57 years on the full-time staff. Colonel R. A. Bayliss left at the end of December.

Government Herbarium, Stellenbosch (STE)

The number of specimens named totalled 4 853 with 333 visitors requiring information. Accessions to the herbarium numbered 1 696.

Mrs M. F. Rand (née Thompson) is continuing with her work on Hypoxidaceae and completed a revision of the small genus *Pauridia*. She is now dealing with *Spiloxene*. She delivered a paper on generic differences in the family at the S.A.A.B. Congress in Stellenbosch.

Miss L. Hugo completed her work on the section *Campylia* in *Pelargonium* and will submit it for an M.Sc. degree at the University of Stellenbosch at the end of 1978.

Mrs A. M. Pietersen left the staff at the beginning of 1979 and was succeeded by Miss G. Garwood.

Several local collecting trips were undertaken, in particular to the site of the large Theewaterskloof Dam to record the flora before final inundation.

S.W.A. Herbarium, Windhoek (WIND)

A total of 6 017 specimens was named and 366 visitors dealt with. Accessions of 2 386 specimens for the year brought the holdings up to 39 167.

Mr M. A. N. Müller continues to run the herbarium and work on a revision of *Eriocephalus*. His duties include lectures at the Neudamm Agricultural College and the Tsumis Agricultural College. He is also responsible for the issue of phytosanitary certificates and export permits for local products among which are the dried roots of *Harpagophytum procumbens* (Pedaliaceae).

Mr H. J. W. Giess continues his work on the local flora in conjunction with the Botanische Staatssammlung, München. He was recently awarded the Certificate of Merit by the South African Association of Botanists for his outstanding and valuable contributions to botany in South West Africa/Namibia.

Mrs J. L. van Aswegen and Mrs H. E. J. Stoffberg are still on the staff, the latter now in the newly created full-day post.

FLORA RESEARCH SECTION

The main task of this section is the preparation of floras of the subcontinent dealing with flowering plants, and cryptogams as well as fossils.

Flora of Southern Africa

The third introductory volume to this series was published: a Bibliography to South African Botany (up to 1951) by Mr A. A. Bullock, formerly of Kew. This work of 194 pages contains some 10 000 references and consists of two parts, an author index and an index to plant groups. It comprises mainly taxonomic literature but deals also with ecology and other fields of botany.

Two volumes are in preparation for the series on Cryptogams.

Vol. 11: A check list of the 907 species of mosses known in the region was published by Dr R. E. Magill. These species belong to 282 genera and 87 families. First drafts of the treatment for the Flora were completed for 71 species, and a total of 86 species was figured in detailed pencil drawings by Mrs Rita Weber.

Vol. 12: In preparation for this volume on ferns a check list of the 241 known species and varieties was produced by Prof. E. A. Schelpe of the Bolus Herbarium and circulated. Most illustrations for this work have been completed by Mrs R. C. Holcroft and others and the greatest portion of the research work has already been done.

In the series on Flowering Plants the following volumes or parts thereof are at an advanced stage of preparation:

Vol. 3: A revision of the 65 species of *Mariscus* (Cyperaceae) and related genera by Dr P. J. Vorster was accepted as a D.Sc. thesis. In the complex genus *Ficinia* (Cyperaceae) more than 30 of the estimated 70 species have been researched in depth by Mr T. H. Arnold. A study of the pattern of silica deposition in the epidermis of seeds is providing an important aid in this investigation.

Vol. 4, part 2: Work on Xyridaceae, Eriocaulaceae, Pontederiaceae and Juncaceae, totalling 42 species, was accepted by Mrs A. A. Mauve. Commeliaceae, the family still outstanding for this part, is being dealt with jointly by Prof. J. P. M. Brenan, Dr R. Faden and Mrs A. A. Mauve.

Vol. 5: In the Liliaceae Mrs A. A. Mauve progressed well with work on genera related to *Urginea* and she completed a publication on the genus *Sypharissa*.

Vol. 10, part 1: This part on Loranthaceae and Viscaceae by Prof. D. Wiens of the University of Utah and Dr H. R. Tölken, formerly of the BRI, now at Adelaide, South Australia, has gone to press and should be available before the end of 1979.

Vol. 11: Revisions of *Lampranthus* and *Gibbaeum* (Mesembryanthemaceae) have been submitted for publication in the Contributions of the Bolus Herbarium by Dr H. F. Glen, who is now studying the sub-tribe Ruschiinae.

Vol. 14: In this volume on Crassulaceae by Dr H. R. Tölken revisions of the following genera were completed: *Cotyledon*, *Tylecodon*, *Kalanchoe* and *Adromischus*. The revision of the genus *Crassula*, which was published in the Contributions of the Bolus Herbarium last year, is being converted to Flora format and the entire volume should be ready for the printers early in 1980.

Vol. 21: A treatment of the family Tiliaceae written many years ago by Prof. H. Wild is being prepared for publication. The 93 species of subgenus *Hermannia* of *Hermannia* written up by Dr I. C. Verdoorn were submitted for publication in Bothalia.

Vol. 25: A revision of *Griesebachia* (Ericaceae) by Mr E. G. H. Oliver will be going to press soon and work on *Thamnos* and *Platycalyx* of the same family was completed.

Vol. 27, part 4: This part which is being prepared by Dr R. A. Dyer deals with a total of 130 species belonging to *Brachystelma*, *Ceropegia* and *Riocreuxia* (all Asclepiadaceae). It has gone to press and should appear before the end of 1979.

Vol. 28: Work on Lamiaceae, a family comprising about 250 species, should be completed by Dr L. E. Codd before the end of 1981.

Palaeoflora of Southern Africa

A revision of *Dicroidium*, a genus of seed-ferns, is being prepared for publication in a volume on the Upper Triassic Molteno Formation by Drs J. M. and

H. M. Anderson. Complete copy for this volume is being typeset on a compositor in the Institute. Large composite photographic plates are compiled and will be reduced to the eventual A4 size. A world-wide review of genera of megaplants of the Permo-Triassic is being compiled by the same two authors with the co-operation of various authorities from different countries. It is planned to publish this work as an introductory volume to the series.

Botanical collectors in Southern Africa

For this work, which is being written by Miss M. D. Gunn and Dr L. E. Codd, the encyclopaedia dealing with plant collectors in alphabetical sequence was completed except for a few late entries which must still be included. An historical introduction was written to provide a chronological account of early collecting activities and of literature dealing with southern African plants, with emphasis on illustrations, up to the time of Linnaeus.

Register of plant taxonomic projects

A new edition of this register, listing some 350 current projects on African plants, is in the last stages of preparation and will again be distributed world-wide in form of microfiche cards.

Southern African Plants

Material for a brochure on 20 of the most important water weeds in the region was compiled. For each species two to three colour photos and a distribution map are provided. The text comprises a short description, a comparison to related species, a note on distribution and paragraphs on ecology, importance, derivation of the scientific name and literature.

Pretoria Flora

With the completion of a further 298 line drawings only 40 species remain to be illustrated. Special attention was given to the large and difficult families Poaceae and Fabaceae. The 235 species of grasses were figured by Mrs Hester Wouda-du Toit while Mr P. C. V. du Toit wrote the text. Dr H. R. Tölken compiled the text for Fabaceae while Mrs R. C. Holcroft did most of the illustrations.

Ceropegia and related genera

A fully illustrated account of the genera *Ceropegia*, *Brachystelma* and *Riocreuxia* by Dr R. A. Dyer is in the final stages of preparation. It will provide information additional to that given in Volume 27, 4 of the Flora of Southern Africa and will cater for the world-wide interest in the group by amateurs.

Liaison Officer, Kew

The Officer, Mr C. H. Stirton, was active along a broad front, especially in the fields of weed research, the taxonomy of Fabaceae and pollination biology. He participated in several symposia and scientific gatherings in the United Kingdom and on the Continent. Numerous herbaria were visited in the course of his research on the weed genera *Lantana* and *Rubus* as well as the genera *Eriosema*, *Psoralea* and related groups. Problems from different fields of botany were researched for scientists and institutes in South Africa and abroad and information was exchanged with botanists around the globe.

Plant anatomy

Mr R. P. Ellis continued his work on the anatomy of the Kranz syndrome in the southern African grasses. Very good correlations were found between the distribution of 'malate' and 'aspartate' type C₄

grasses in South West Africa and the rainfall. Malate formers were shown to increase with increasing precipitation whereas aspartate formers decreased and were most common in the Namib and pre-Namib areas. This is the first time that an ecological relationship has been demonstrated for these sub-types of the C_4 photosynthetic pathway. This has only been possible because of the extensive collection of grass leaf blade anatomical preparations assembled during the course of this project.

A further two field trips were undertaken to the Drakensberg mountains in Natal to collect and study members of the genus *Merxmüllera*. Anatomical results clearly demonstrate that, in both *M. disticha* and *M. stricta*, three distinct anatomical "forms" occur in the Drakensberg mountains in addition to the typical "form" found further south in the Cape Province. These "forms" all have characteristic leaf anatomy, display morphological similarities as well as having similar habitat requirements, and appear to warrant taxonomic status.

The most serious infestations of the noxious weed, *Opuntia aurantiaca*, occur in the eastern Cape area. Dr T. B. Vorster and Mr T. H. Arnold visited this area and determined, by cytogenetical studies, that in South Africa this problem plant originating from Argentina, is represented by only one biotype. In Argentina *O. aurantiaca* forms a complex consisting of hundreds of biotypes, but Dr Vorster is of the opinion that the plant which has invaded the eastern Cape is the vegetative progeny of a single plant, or a few genetically identical plants.

BOTANICAL SURVEY SECTION

The function of the Botanical Survey Section is to study the vegetation of South Africa and its ecological relationships. This work covers three main fields of activity: (1) The identification, description and mapping of various vegetation classes; (2) the study of the ecological relationships between different types of vegetation—mutually and with the environment—and also of the various processes and mechanisms that govern the behaviour of plant communities; (3) the development of various methods and techniques required for ecological studies of vegetation. In this work there is close co-operation with the Data Processing Section, to which ecosystems research has been transferred.

Veld types of South Africa

At the time of Mr J. P. H. Acocks's death in May 1979, the revision of the veld types of the western half of the country was approaching completion. He had completed writing up all the 25 Karoo and False Karoo types together with the west- and south-coastal types, and part of the Kalahari Thornveld. These amount to 32 veld types in all, subdivided into 89 variations. The revision excludes the Mountain Fynbos and the False Fynbos. Part of the revised treatment of Kalahari Thornveld remains to be done.

Western Transvaal bushveld survey

The final report on this project was presented as a Ph.D. thesis by Dr F. van der Meulen and published in the series *Dissertationes Botanicae* as Band 49 (1979), the title being "Plant sociology of the western Transvaal Bushveld, South Africa: a syntaxonomic and synecological study".

Zululand coastal dune survey

The impact of mineral prospecting on dune vegetation in Reserve 10 (Zululand) was uneven, the sea-

ward slope of the dune being the most sensitive area. Regeneration of vegetation on the sampling lines was good. A preliminary evaluation of conservation priorities by Dr P. J. Weisser has shown most of the area to be of secondary character and low in conservation priority.

Wilderness Lakes study

The macrophyte encroachment problem of the Wilderness Lakes in the Cape Midlands was studied by Dr P. J. Weisser at the request of the Lake Areas Development Board (George). An increase of macrophytes such as *Potamogeton pectinatus*, *Phragmites australis* and *Typha latifolia* subsp. *capensis* in some areas was found and mechanical control suggested.

Vegetation survey of the Cape of Good Hope Nature Reserve

For the assessment of the rate of infestation of pest-plants (or plant invaders) during the study period starting in 1966, Mr H. C. Taylor carried out the re-enumeration of pest plant density on 29 sample plots during the year. The geographic position of 10 of these permanent samples, previously lost, had to be re-established by compass and distance-measure.

A primary survey of Rooiberg Mountain Catchment Reserve near Ladismith, Cape

The completion of the quantitative floristic survey by Mr H. C. Taylor confirmed the expected high degree of correlation between the physiognomic and phytosociological classifications reported on last year. The results of the reconnaissance survey, including management recommendations, were embodied in a 47-page report, with five appendices, 28 photographs, two maps and a phytocoenon table submitted to the Secretary for Forestry, as requested.

A classification based on structural-functional characteristics of the vegetation

In this, the first year of the project, Mr B. M. Campbell spent a considerable time on methodology. He completed a literature survey, tested ideas for the classification in the field, compiled a computer-package for the manipulation and analysis of structural-functional data, and wrote a paper on methodology. In the latter part of the year, he began his sampling programme. A third of the necessary data has now been collected.

Distribution and autecological aspects of the Hakea pest plants

Mr S. R. Fugler has drawn and analysed distribution maps for the three South African pest *Hakea* spp. and improvements in the present *H. sericea* mechanical control programme have been suggested. Evidence indicates that all infestations of *H. suaveolens* and *H. gibbosa* can be eradicated in South Africa except the *H. gibbosa* infestation in the Kleinriviersberge and adjoining mountains. A management programme for these mountains has been proposed. Methods for estimating the density and fruit load of *H. sericea* for a given infestation have been designed and the phenology of the pest *Hakea* species has been studied.

Fynbos biome project

In October the Task Group searched for and found a suitable site to replace the proposed west coast study site which had been burnt.

Mr H. C. Taylor prepared a chapter on "The Phytogeography of Fynbos" for a volume to be published by the CSIR synthesizing present knowledge on the Fynbos Biome.

Semi-detailed survey of the vegetation of the western and southern Cape coastal lowlands

Mr C. Boucher's sampling of the natural vegetation along transects through the first priority western coastal foreland progressed as follows: 1. Langebaan Lagoon to Saron—100 km long; 150 floristic samples; preliminary sampling complete. 2. Buck Bay to Bainskloof—70 km long; 100 floristic and 100 physiognomic samples; 22 km sampled. 3. Table Bay to Stellenbosch—35 km long; 26 samples; 10 km sampled. 4. Orange River mouth to Table Bay littoral zone—82 samples; sampling complete. Existing computer programmes were modified and new programmes were written to analyse these data. Approximately half of the data has been coded for analysis.

Littoral vegetation of the southern Cape

To provide quantitative data for a contribution to a book on dry coastal ecosystems (in Elsevier's Series Ecosystems of the World), a phytosociological study of littoral vegetation of the southern and western Cape is being conducted. During the year floristic data from 163 relevés were collected along the southern Cape coast from Cape St Francis to Cape Point. Provisional indications are that the sand-dune flora is remarkably uniform but there is considerable variation in the flora of the rocky coasts.

Orothamnus project

Mr C. Boucher visited the known populations of the marsh rose (*Orothamnus zeyheri*) in the Kogelberg State Forest during December 1978. Population size and development of selected individuals are monitored annually. Preliminary results indicate that it takes at least eight years for half the individuals in a population to reach flowering maturity. A total of 1180 individuals was recorded in the area.

Aquatic ecology

The Braun-Blanquet classification of the "water-plant" communities of Natal together with a paper entitled: "*A preliminary classification of the water-plant communities of Natal*", intended for publication, have been completed by Mr C. F. Musil. Water-plant communities have been set out in a synoptic table and each described in detail. The communities follow a broad salinity and pH gradient and have been divided into 6 major groups. These are (1) marine, (2) estuarine, (3) brackish water, (4) moderately fresh to slightly brackish water, (5) fresh-water, and (6) communities found in fast-flowing fresh-water.

Mr C. F. Musil has completed more than a year's field measurements, at fortnightly intervals, of growth rates and chemical composition of water-hyacinth plants, together with chemical and physical parameters of the water and environment. Present synthesis of data has revealed an apparent linear relationship between diffuse radiant flux and growth rate of water-hyacinth plants. This suggests that light is the primary factor limiting water-hyacinth growth, where previously the effect of light was considered to be minimal. Mr Musil has practically completed a detailed report, critically evaluating the literature, methods and culture techniques employed, that will contribute to the "methods" section of the final report.

NAKOR National Conservation Plan

Dr J. C. Scheepers and Miss B. K. Drews continue to co-ordinate the NAKOR National Conservation Plan for the Department of Environmental Planning and Energy, in co-operation with an officer of that Department. A staff change in the latter Department

has interrupted continuity, but progress continues. Approval has been obtained and funds earmarked for the setting up of a data bank for efficient storage, retrieval and processing of the rapidly accumulating data, using the computer of the Department of Agricultural Technical Services.

DATA PROCESSING AND ECOSYSTEM STUDIES SECTION

The mandate of this relatively new section is the provision of data processing facilities for research purposes to the rest of the Institute as well as undertaking plant ecological research at the ecosystem (function) level. The largest data processing task under development, the computerization of the National Herbarium, is almost complete. Our contribution to the Savanna Ecosystem Project at Nylsvley, determination of biomass relations and seasonal biomass change in dominant tree and shrub species has made good progress and a report on biomass relations has been published. The Savanna Ecosystem Project data bank is administered by this Section, under the control of Dr J. W. Morris. He is also responsible for co-ordination of modelling activities as well as research in the Decomposer Component of the Project.

The National Herbarium Data Bank has changed to the status of a production system, although the last few tests of programmes forming part of the system are still being done. An intensive process of correcting errors in the data is under way and will be completed soon by Dr H. F. Glen. The production of realistic maps showing the distribution of specimens selected from the data bank is a facility which is in the process of being added to the system.

In a project being undertaken for the Savanna Ecosystem Project by Dr. M. C. Rutherford, it has been found that a considerable proportion of photo synthate is "lost" to the formation of wood material in savanna vegetation but that water relations are important in interpreting radial stem growth measurements. In another project, he has found that increased fire damage to *Ochna pulchra* canopies results in a greater proportion of basal coppice material. Tree height has been found to influence the relative wood-leaf composition of basal coppice material and to influence several other plant properties following upon fire.

ECONOMIC BOTANY SECTION

The work programme of the section, under Mr M. J. Wells consists of: plant utilization research (including ethno- and palaeo-ethno botany), weed research, plant geography, the conservation of plant resources, and the provision of an information service spanning these fields. In addition the section hosts work on the new palaeo-flora of southern Africa.

Until recently the accent of the section's work was weed research, but this has diminished as a result of: the temporary transfer to Kew of the leader of the weed research team (Mr C. H. Stirton); the conclusion of Mr Wells's investigation of nassella tussock—for which control measures have now been instituted; the decision of the Department to establish a Weed Research Centre, which will in future co-ordinate work (including botanical work) on weeds.

At present the section is completing its work on a number of weed projects that will be basic to the work of the new Weed Research Centre (e.g. the provision of a national weed list), and is preparing to register

new projects in the field of plant utilization, and the conservation of plant resources. These projects will fall under the newly appointed team leader, Mr T. H. Arnold.

Plant utilization

Mr Arnold has commenced a literature study on the utilization of South African plants, as a preliminary to registration of an umbrella project. The first component of this is a project on barrier plants.

Other projects will include research on the origins of indigenous crop-plants. Mrs B. van Gass planted out, and harvested seed of all entries in our *Citrullus* (water-melon) collection, under the direction of Dr B. de Winter. Several new entries, including one from the Seychelles, were added to the collection which now includes an interesting range of wild species and eco-types.

Miss C. A. Liengme returned after completing her B.Sc. Hons at Natal University, Pietermaritzburg. She finalized her report on the ethnobotany of the Tsonga of Gazankulu, and completed a literature study of the ethnobotany of tribal peoples in South Africa. This will form the basis for registration of an umbrella project on ethnobotany, and will provide the background for more detailed research on Tsonga ethno-botany, which she is about to begin.

Conservation of plant resources

The first stage of a project to conserve germ plasm of primitive crop cultivars and of rare and endangered indigenous species is under way, and a survey of over 200 literature references has been completed by the project leader, Mr Arnold. Work on this and on the related, plant utilization project will be carried out by two new appointees: Miss K. J. Duggan, from the University of Natal in Durban; and Miss L. Henderson, from the University of the Witwatersrand.

Weed research

A first national weed list was drawn up, mainly from the literature, by Mr G. B. Harding, prior to his leaving for Natal University (PMB) where he has been seconded for his honours course. The list has since been added to by other staff members, notably Mr A. A. Balsinhas, and now includes the names of over 700 plants of which about 30% are indigenous.

This list is to provide a basis for sorting weeds into categories, distinguishing weed-complexes, making weed status evaluations, and can ultimately provide the basis for legislation.

Material of all the exotics on the list, and the species of world-wide distribution, has been sent to Mr C. H. Stirton at Kew, for checking of identification, so that the weed status of these species can be evaluated on the basis of available literature.

Pilot studies have also been completed on two methods of carrying out weed surveys to provide qualitative and quantitative information for future weed status and weed-complex evaluations. In the first of these we experimented with sampling agronomic weeds. Messrs Harding and Balsinhas and Mrs van Gass carried out this experiment: collecting soil samples in cultivated fields in winter, germinating weeds from the soil samples under nursery conditions, and then comparing the species found in the field with those germinated in the nursery. This method needs considerable refinement, but the results obtained suggest that it can be used to enable us to carry out

a country-wide survey with the help of local collectors, thus reducing survey costs and the use of expert manpower.

The second of these projects, carried out by Misses Henderson and Duggan, was a survey of woody, exotic invaders in the Pretoria-Witwatersrand-Vereeniging area of the Transvaal highveld. Approximately 30 woody species were found to be encroaching in streambank and roadside habitats and in the open veld. *Melia azedarach* (syringa), *Acacia dealbata* (silver wattle) and *Acacia mearnsii* (black wattle) are the commonest woody, roadside invaders, whilst *Salix babylonica* (weeping willow) and *Populus alba* (white poplar) are the commonest woody, streambank invaders. *Arundo donax* (Spanish Reed) is common in both habitats, and is replacing *Phragmites* in some places.

Mrs W. G. Gaum continued her work on a cytogenetic evaluation of the *Lantana camara* complex, under the direction of Dr T. B. Vorster. Chromosome counts have been completed for all the variants so far found in South Africa. The accent is now on the search for embryo-sac abnormalities. The investigation is still incomplete, but at this stage there are no grounds for considering any of the variants to be safe to cultivate.

A quick survey of local nurseries, carried out by Mrs D. M. C. Fourie and Mr Balsinhas showed that most of them are still selling *Lantana camara* although it is a declared-noxious weed.

Mr Stirton will complete the bio-taxonomic aspects of the *Lantana* study when he returns from Kew in 1980.

A highlight of the year was the appearance of the book 'Plant invaders: beautiful but dangerous' compiled and edited by Mr Stirton for the Cape Department of Nature and Environmental Conservation. It enables the layman to identify 26 of the worst plant invaders of the Cape Province, and provides information on how to counter the threat that they pose.

A short study of *Prosopis* (mesquite) in the northern Cape, carried out by Mr Harding, showed that, of the three species recorded as having been introduced to South Africa, two are invasive, namely *P. glandulosa* (honey mesquite) and *P. veluti* (velvet mesquite). The third species, *P. pubescens* (screw bean), does not appear to be causing trouble.

The long-awaited book on poisonous plants by Mr J. H. Vahrmeyer is still at the printers, awaiting publication. The text has been translated from Afrikaans into English by Mrs E. Brink, of the research unit at Grahamstown, and Mr Wells has edited both versions.

Miss S. M. Bulley, a new staff member from Natal University in Durban, has started a two year autecological study of nassella tussock (*Stipa trichotoma*). She is stationed at Cape Town University, where she is under the direction of Dr A. V. Hall. The object of this study is to find ways of modifying and improving our control strategies for this plant.

Plant geography

Dr J. M. Anderson continued his survey of the distribution of woody plants in the Transvaal. Two hundred and eighty field listings of woody plants were made. Listings have now been made in nearly 1 700 of the $\pm 7\ 000\ 1/16^{\text{th}}$ squares that occur in the survey area. The first objective, a 10% sampling cover, has been achieved for nearly the whole area, whilst the

ultimate objective, a sampling cover of 25% has been achieved in over half the area. The listings are being used to plot the distributions of all of the ± 900 species of indigenous woody plants that occur in the Transvaal.

The palaeoflora of southern Africa

It has been decided to describe the fossil plants of southern Africa in a 'flora' as a companion series to the extant flora series. This work is in the hands of the husband and wife team Drs J. M. and H. M. Anderson. Good progress has been made on an introductory volume and one on the Molteno Formation. Already some 5 000 fossil plant specimens have been collected, the photographic plates illustrating about 1 000 specimens have been prepared, and the text, tables and maps are nearing completion. This project is of world-wide interest since, in order to cover the South African fossil flora adequately, the whole of Gondwanaland will have to be treated.

The information service

Mrs Fourie, scientific information officer for the Institute, handled 283 requests for information about economic plants, and their utilization or control. These included about 440 identifications. Particular interest was shown in the newly declared noxious weeds: *Sesbania punicea* and *Pereskia* spp.; and in the utilization of indigenous *Euphorbia* spp. and the Mexican rubber bush (or guayule) *Parthenium argentatum*.

Colour-slide collection

Nine hundred and fifty labelled colour-slides of plants were added to the Institutes' collection which is curated by Mr Balsinhas.

GARDEN SECTION

Mr J. Erens continued in charge of the garden whilst Mr D. S. Hardy was in charge of the nursery.

There were 1 127 accessions to the garden during the year including Mr Hardy's collection of 500 succulents from South West Africa. Mrs B. C. de Wet and Mrs K. P. Clarke, continued with the mammoth task of labelling and record keeping.

In the garden the most striking development was in the savanna biome area, where Mr H. J. de Villiers and Mr T. A. Ankiewicz landscaped the area adjacent to the Silverton road, building rock-covered koppies that will soon be the home of wild figs and other lowveld species. All the beds in this biome area have now been demarcated, and most of them have been sown to *Eragrostis curvula*, which provides an attractive, soil-binding cover. The areas between the beds have been planted with lawn grass, and 120 savanna trees were planted out. The water reticulation system of the savanna biome area is now complete, except for the 'Aloe koppie'.

Progress in the coast forest biome area, where Mr Ankiewicz is in charge, has also been rapid. Most of the excavation of soil, and landscaping of an area for swamp forest development has been done. The reticulation system has been completed and, as in the savanna biome area, paths to the plantings serve a dual function by also providing access to the water pipes. One hundred and fifty trees and shrubs were added to the coast forest plantings.

The fynbos biome has not fared so well—replantings of Proteaceae having suffered during the hot, dry summer of 1978/9. The summer display, consisting of about 25 000 *Pelargonium*, *Gazania*, *Arctotis*, *Dimorphotheca*, *Diascia*, *Felicia* and mesem plants, was effective, but also suffered from the drought, whereas the earlier display of spring annuals was outstanding.

Floral decorations were provided for about 80 special occasions during the year. We were also glad to have contributed to the South African gold medal exhibit at the Chelsea Flower Show.

BOTANICAL RESEARCH INSTITUTE

Scientific, Technical and Administrative Staff

(30th June 1979)

Director

B. de Winter, M.Sc., D.Sc. (Taxonomy of Poaceae, especially *Eragrostis*, and of *Hermannia*; plant geography)

Deputy Director

D. J. B. Killick, M.Sc., Ph.D., F.L.S. (General taxonomy and mountain ecology)

Assistant Director

D. Edwards, M.Sc., Ph.D. (Ecological methodology; aquatic plants, remote sensing and vegetation structure and physiognomy)

ADMINISTRATION

Administrative Officer....	D. F. M. Venter
Senior Administrative Assistant (Personnel)	Mrs G. E. Hussem, B.A.
Assistant Accountant....	A. Smith
Senior Administrative Assistant	J. Conradie
Administrative Assistants	Mrs J. Rautenbach C. J. Smith (temporary)
Senior Clerical Assistant	Mrs T. Creffield (Registry)
Clerical Assistants.....	Mrs C. A. Bester Mrs I. J. Joubert* (Registry)
Receptionist.....	Mrs M. E. M. Venter
Typists.....	Mrs N. Miller* Mrs S. M. Thiant* Mrs J. Gerke*
Driver.....	H. L. Reyneke

HERBARIUM SERVICES SECTION

Officer in Charge..... E. G. H. Oliver, M.Sc.

NATIONAL HERBARIUM, PRETORIA (PRE)

Chief Professional Officers	E. G. H. Oliver, M.Sc. (Curator; Ericaceae) Mrs E. van Hoepen, M.Sc. (Assistant Curator; supervision of identifications and enquiries)
Technical Assistant.....	Mrs E. D'Alebout

Wing A (Cryptogams—Monocotyledons)

Chief Professional Officer	Mrs E. van Hoepen
Senior Professional Officer	R. E. Magill, M.S., Ph.D. (Musci)
Professional Officer.....	Miss C. Reid, B.Sc. Hons
Technician.....	Miss L. Smook, B.Sc. (Poaceae)
Technical Assistants.....	Mrs P. W. van der Helde Mrs L. R. Filter* Mrs A. M. Fourie* J. van Rooy (Musci)

Wing B (Piperaceae—Oxalidaceae)

Senior Professional Officer	G. Germishuizen, B.Sc. Hons (Polygonaceae)
Technician.....	D. A. Davies, B.Sc.
Technical Assistant.....	Mrs I. R. Leistner*

Wing C (Linaceae—Asclepiadaceae)

Senior Professional Officer	Miss E. Retief, M.Sc. (Campanulaceae)
Professional Officer.....	P. P. J. Herman, B.Sc. Hons
Technician.....	Mrs M. J. A. W. Crosby, B.Sc.*
Technical Assistants.....	Mrs J. L. M. Grobler* C. Hildyard, B.Sc. (Elec. Eng.) (part-time)

Wing D (Convolvulaceae—Asteraceae)

Chief Professional Officer	Miss W. G. Welman, M.Sc.
Professional Officer.....	Mrs S. J. Smithies, M.Sc.
Technical Assistants.....	G. J. Goosen Mrs K. A. Kleynhans*

Service Room

Technical Assistants.....	Mrs I. Ebersohn Mrs G. L. Radmacher
Typist.....	Mrs A. M. Verhoef

Photographic Room

Photographer.....	Mrs A. J. Romanowski
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NATAL HERBARIUM, DURBAN (NH)

Senior Professional Officer	P. C. V. du Toit, M.Sc. (Curator; Poaceae especially <i>Pentaschistis</i> , and general identifications)
Technician.....	Mrs B. J. Pienaar, B.Sc.
Technical Assistant.....	Miss A. L. Wright

ALBANY MUSEUM HERBARIUM, GRAHAMSTOWN (GRA)

Senior Professional Officer	Mrs E. Brink, B.Sc. (Curator; general identifications)
Technical Assistants.....	Vacancy Miss G. V. Britten*

GOVERNMENT HERBARIUM, STELLENBOSCH (STE)

Senior Professional Officers	Mrs M. F. Rand, M.Sc. (Curator; Hypoxidaceae and general identifications) Miss I. Hugo, B.Sc. Hons (<i>Pelargonium</i> and general identifications)
Technical Assistant.....	Miss G. D. Garwood
Clerical Assistant.....	Miss E. N. Pare

WINDHOEK HERBARIUM (WIND)

Senior Professional Officer	M. A. N. Müller, M.Sc. (Curator; <i>Eriosephalus</i> and general identifications)
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* Half-day

Technician.....	H. J. W. Giess (Poaceae and trees of South West Africa/Namibia)
Technical Assistants.....	Mrs H. E. J. Stoffberg Mrs J. L. van Aswegen

FLORA RESEARCH SECTION

Officer in Charge.....	O. A. Leistner, M.Sc., D.Sc., F.L.S.
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FLORA OF SOUTHERN AFRICA TEAM

Chief Professional Officer	O. A. Leistner, M.Sc., D.Sc., F.L.S. (Taxonomy, especially Malvaceae)
Senior Professional Officers	L. E. W. Codd, M.Sc., D.Sc. (Taxonomy, especially Lamiaceae, and early plant collectors)
	R. A. Dyer, M.Sc., D.Sc., F.R.S.S.Af., F.A.S.S. (Taxonomy, especially Asclepiadaceae)
	Mrs G. E. Gibbs Russell, B.S., Ph.D. (Taxonomy, especially aquatic plants and Cyperaceae)
	Mrs A. A. Obermeyer-Mauve, M.Sc. (Taxonomy, especially Monocotyledons)
	C. H. Stirton, M.Sc. (Liaison Officer, Kew; taxonomy, especially Fabaceae and weeds)
Technicians.....	Mrs R. C. Holcroft* (artist)
	Mrs A. M. Weber (artist)
Technical Assistant.....	Mrs C. F. Fourie*

ANATOMY—CYTOGENETICS LABORATORY

Chief Professional Officers	R. P. Ellis, M.Sc. (Anatomy of southern African grasses)
	T. B. Vorster, M.Sc., D.Sc. (Agric.) (Cytogenetics of <i>Eragrostis curvula</i> Complex)
Technician.....	Miss R. Manders, B.Sc.
Technical Assistant.....	Miss E. van Gylswyk

BOTANICAL SURVEY SECTION

Officer in Charge.....	J. C. Scheepers, M.Sc., D.Sc.
Chief Professional Officers	J. C. Scheepers, M.Sc., D.Sc. (Vegetation ecology, especially of forest / woodland / savanna / grassland relationships; conservation and land-use planning; phytogeography)

H. C. Taylor, M.Sc. (O/C Botanical Research Unit, Stellenbosch; mountain fynbos and forest ecology; Braun-Blanquet approach and techniques; conservation)

C. Boucher, M.Sc. (Lowland fynbos ecology and phytosociology; conservation and land-use planning; Braun-Blanquet approach and techniques)

Senior Professional Officers C. F. Musil, M.Sc. (Aquatic ecology and survey of aquatic plants, especially in Natal; ecophysiological studies on *Eichhornia crassipes* and *Salvinia molesta*)

P. J. Weisser, Ph.D. (Reedswamp ecology; ecological planning and environmental impact studies; Zululand coast dune vegetation; conservation)

Professional Officers..... B. M. Campbell, B.Sc. Hons (Physiognomic-structural classification of fynbos; fynbos phytosociology; quantitative methods)

S. R. Fugler, B.Sc. (Ecological survey of invasive aliens in fynbos, especially *Hakea* spp.)

R. H. Westfall, B.Sc. Hons (Ecology and phytosociology of Transvaal Bushveld)

Miss B. K. Drews, B.Sc. Hons (Ecological planning and environmental impact studies; conservation)

Technicians..... P. A. Shepherd, B.Sc. (Lowland fynbos ecology and phytosociology, threatened species)

Mrs M. Engelbrecht, B.A. Hons (Fine Arts) (Draughtsmanship and cartography; artwork, layout and design)

Miss A. J. Naudé, B.Sc. (Ecological data processing and presentation, ecological literature, nature conservation, air-photo interpretation, cartography)

Technical Assistant..... Miss Y. Myburgh (Draughtsmanship and cartography; artwork, layout and design)

DATA PROCESSING AND ECOSYSTEM STUDIES SECTION

Officer in Charge.....	J. W. Morris, M.Sc., Ph.D.
Chief Professional Officers	J. W. Morris, M.Sc., Ph.D. (Data process- ing and quantitative ecology)
	M. C. Rutherford, M.Sc., Ph.D., Dipl. Datamet. (Biomass and production studies in savanna and fynbos)
Senior Professional Officer	H. F. Glen, M.Sc., Ph.D., F.L.S. (Data process- ing, numerical tax- onomy and Mesembry- anthemaceae)
Technician.....	B. Curran
Learner Technician.....	M. D. Panagos
Technical Assistants.....	Vacant
	Mrs J. H. Jooste*
	Mrs L. E. Oosthuizen*
	Mrs N. Nigrini*
Administrative Assistant	Mrs J. Mulvenna
Clerical Assistants.....	Mrs S. Smit*
	Mrs B. Rooke*

ECONOMIC BOTANY SECTION

Officer in Charge.....	M. J. Wells, M.Sc.
Chief Professional Officer	M. J. Wells, M.Sc., (Weed research, pa- laeo-ethnobotany and botanical horticulture)
Senior Professional Officers	J. M. Anderson, Ph.D. (Palaeo - ethnobotany, plant geography and paleo-flora)
	T. H. Arnold, M.Sc. (Conservation of germ plasm and plant utili- zation)
Professional Officers.....	Miss C. A. Liengme, B.Sc. Hons (Ethnobo- tany)
	G. B. Harding, B.Sc. (Weed research)
	Miss K. J. Duggan, B.Sc. Hons (Conservation of germ plasm and plant utilization)

Miss L. Henderson, B.Sc.
Hons (Conservation of
germ plasm and plant
utilization)

Miss S. M. Bulley,
B.Sc. Hons (Weed
research)

Senior Technician..... Mrs H. M. Anderson,
Ph.D. (Palaeo-flora)

Research Technicians.... Mrs D. M. C. Fourie,
B.Sc. (Scientific infor-
mation service and
identification of exo-
tics)

Mrs W. G. Gaum, B.Sc.
(Cytogenetics)

Mrs B. van Gass, N.D.
Hort. (Garden utiliza-
tion)

Technical Assistant..... A. A. Balsinhas (Plant
collecting)

PRETORIA BOTANICAL GARDEN

Acting Curator (Garden)	J. Erens
Acting Curator (Nursery)	D. S. Hardy
First Technicians.....	D. S. Hardy (Nursery supervision, succulents and orchids)
	H. J. de Villiers, NTC III (Hort.), Dipl. Rec. P.A. (Development savanna biome)
Senior Technicians.....	J. Erens (Garden super- vision and administra- tion)
	T. A. Ankiewicz, Dip. For. (Administration, stores and purchases, development coastal forest biome)
Technical Assistants.....	Mrs B. C. de Wet*, B.A. (Garden records)
	Mrs K. P. Clarke* (Garden records)
Learner Technician.....	Miss Y. Mennin
Farm Foremen.....	G. J. Stolz
	H. N. J. de Beer
T.N. 4 Supervisor.....	L. C. Steenkamp
T.N. 6.....	J. P. Booysens

* Half-day

PUBLICATIONS BY THE STAFF

ACOCKS, J. P. H., 1979. The flora that matched the fauna.
Bothalia 12: 673-709.

ANDERSON, H. M., 1978. Podozamites and associated cones
and scales from the upper Triassic Molteno Formation,
Karoo Basin, South Africa. *Palaeont. Afr.* 21: 57-77.

ANDERSON, J. M. & CRUICKSHANK, A. R. T., 1978. The
biostratigraphy of the Permian and Triassic, part 5—a
review of the classification and distribution of the permo-
triassic tetra-pods. *Palaeont. Afr.* 21: 15-44.

ARNOLD, T. H., 1979. *Ficinia radiata* (L.f.) Kunth. *Flower.*
Pl. Afr. 45: t. 1784.

BOUCHER, C. & BOUCHER, D. A., 1978. Uitheemse indringer-
plante bedreig die Kaapse Weskus. *Elsenburg J.* 2 (1): 1-11.

BOUCHER, C. & STIRTON, C. H., 1978. *Acacia cyclops*. A.Cunn.
ex G.Don. In C. H. Stirton, *Plant invaders—beautiful, but
dangerous* pp. 40-43. Cape Town: Dept. of Nature &
Environmental Conservation of the Cape Provincial
Administration.

BOUCHER, C. & STIRTON, C. H., 1978. *Acacia longifolia* (Andr.)
Wild. In C. H. Stirton, *Plant invaders—beautiful, but
dangerous* pp. 44-47. Cape Town: Dept. of Nature &
Environmental Conservation of the Cape Provincial
Administration.

BOUCHER, C. & STIRTON, C. H., 1978. *Acacia saligna* (Libill.)
Wendl. In C. H. Stirton, *Plant invaders—beautiful, but
dangerous* pp. 60-63. Cape Town: Dept. of Nature &
Environmental Conservation of the Cape Provincial
Administration.

BOUCHER, C. & STIRTON, C. H., 1978. *Acacia mearnsii* de Wild.
In C. H. Stirton, *Plant invaders—beautiful, but dangerous*
pp. 48-51. Cape Town: Dept. of Nature & Environmental
Conservation of the Cape Provincial Administration.

BOUCHER, C. & STIRTON, C. H., 1978. *Acacia pycnantha* Benth.
In C. H. Stirton *Plant invaders—beautiful, but dangerous*
pp. 56-59. Cape Town: Dept. of Nature & Environmental
Conservation of the Cape Provincial Administration.

- BULLOCK, A. A., 1978. Bibliography of South African botany (up to 1951). *Flora sth. Afr.* Introductory volume, pp. 194.
- CAMPBELL, B. M., 1978. Similarity coefficients for classifying relevés *Vegetatio* 37: 101–109.
- CODD, L. E., 1979. *Plectranthus praetermissus*. *Flower. Pl. Afr.* 45: t. 1791.
- DE WINTER, B., 1979. Die bydrae van taksonomie en bio-sistematiek in die ontwikkeling van Suid-Afrika. *Bothalia* 12: 742–745.
- DE WINTER, B., KILICK, D. J. B. & EDWARDS, D., 1979. Terrestrial ecology in South Africa. *S. Afr. J. Sci.* 75: 59–61.
- DOWNING, B. H., ROBINSON, E. R., TROLLOPE, W. S. W. & MORRIS, J. W., 1978. Influence of macchia eradication techniques on botanical composition of grasses in the Döhne Sourveld of the Amatole Mountains. *Proc. Grassld. Soc. Sth. Afr.* 13: 111–115.
- DYER, R. A., 1978. The changing scene in *Ceropegia* and *Brachystelma*. *Cactus Succ. J., Los Ang.* 50. (May–June), 112–114.
- DYER, R. A., 1978. *Kalanchoe robusta*. *Flower. Pl. Afr.* 45: t. 1783.
- DYER, R. A. 1978. *Cyrtanthus odoratus*. *Flower. Pl. Afr.* 45: t. 1787.
- DYER, R. A., 1978. *Pelargonium acetosum*. *Flower. Pl. Afr.* 45: t. 1800.
- DYER, R. A., 1979. Looking back. *Cactus Succ. J., Los Ang.* 51 (May–June): 116–117.
- DYER, R. A., 1979. A new combination in *Cyrtanthus*. *Bothalia* 12: 627.
- DYER, R. A., 1979. New records of *Brachystelma*. *Bothalia* 12: 627–629.
- DYER, R. A., 1979. New records of *Ceropegia*. *Bothalia* 12: 629.
- DYER, R. A., 1979. The *Riocrexia flanaganii* Complex. *Bothalia* 12: 632.
- DYER, R. A., 1979. A new species of *Stapelia*. *Bothalia* 12: 632.
- EDWARDS, D., 1977. Is there a need for strict control of nature reserves? *Koedoe* suppl. 95–105.
- EDWARDS, D., 1979. The rôle of plant ecology in the development of South Africa. *Bothalia* 12: 748–751.
- EDWARDS, D., 1978. The rôle of plant ecology in the development of South Africa. *Environment RSA* 5 (8): 5–6 & 5 (9): 6–8.
- ELLIS, R. P., 1979. A procedure for standardizing comparative leaf anatomy in the Poaceae. II. The epidermis as seen in surface view. *Bothalia* 12: 641–671.
- ELLIS, R. P., MANDERS, R. & OBERMEYER, A. A., 1979. Anatomical observations on the peduncle of *Xyris capensis*. *Bothalia* 12: 637–639.
- FURNISS, P. R. & MORRIS, J. W., 1979. Current modelling activities within Savanna Ecosystem Project. *S. Afr. J. Sci.* 75: 108–109.
- GLYPHIS, J., MOLL, E. J. & CAMPBELL, B. M., 1978. Phytosociological studies on Table Mountain, South Africa: 1. The Back Table. *Jl S. Afr. Bot.* 44: 291–295.
- HARDING, G., 1978. *Prosopis glandulosa* Torrey. In C. H. Stirtion, *Plant invaders—beautiful, but dangerous* pp. 128–131. Cape Town: Dept. of Nature & Environmental Conservation of the Cape Provincial Administration.
- HEEG, J., BREEN, C. M., COLVIN, P. M., FURNESS, H. D. & MUSIL, C. F., 1978. On the dissolved solids of the Pongolo flood plain pans. *J. Limnol. Soc. Sth. Afr.* 4 (1): 59–64.
- HUNTLEY, B. J. & MORRIS, J. W., 1978. Savanna Ecosystem Project: Phase I summary and Phase II progress. *S. Afr. Nat. Sci. Prog. Rep.* 19: 1–52.
- KILICK, D. J. B., 1978. More remarks on specific epithets. *Veld & Flora* 64: 36.
- KILICK, D. J. B., 1978. The Mary Gunn Library. *Veld & Flora* 64: 125–128.
- KILICK, D. J. B., 1978. The Mary Gunn Library. *The Mafeking Mail* 1 (5): 3–4.
- KILICK, D. J. B., 1978. Roadside recognition of trees. *AA outdoor holiday guide of South Africa* 6–11.
- KILICK, D. J. B., 1979. Notes on Flacourtiaceae. *Bothalia* 12: 635–636 (1979).
- KILICK, D. J. B., 1979. Omission of *Hypericum oligandrum* from Flora of Southern Africa. *Bothalia* 12: 633 (1979).
- KILICK, D. J. B., 1979. Review: Mountain splendour by R. O. Pearse. *Veld & Flora* 65: 63–64 (1979).
- KILICK, D. J. B., 1979. The contributions of the Botanical Research Institute to botany in South Africa. *Bothalia* 12: 740–742.
- LÄIDLER, D., MOLL, E. J. & CAMPBELL, B. M., 1978. Phytosociological studies on Table Mountain, South Africa: 2. The Front Table. *Jl S. Afr. Bot.* 44: 291–295.
- LEISTNER, O. A., 1979. Southern Africa. In R. A. Perry & D. W. Goodall, *Arid-land ecosystems: structure, functioning and management* 1: 109–143. Cambridge: Cambridge University Press.
- LEISTNER, O. A., 1979. Review: A field guide to the trees of of Southern Africa by Eve Palmer. *Bothalia* 12: 759.
- LEISTNER, O. A., 1979. Review: Trees of Southern Africa by Keith Coates Palgrave. *Bothalia* 12: 759.
- LEISTNER, O. A., 1979. Review: Heil-und Giftpflanzen in Südwesafrika by Eberhard von Koenen. *Bothalia* 12: 759–760.
- LINDER, P. & CAMPBELL, B. M., 1979. Towards a structural-functional classification of fynbos: a comparison of methods. *Bothalia* 12: 723–729.
- MAGILL, R. E., 1979. Amendment to proposal 440: Conservation of Entodontaceae Kindberg. *Taxon* 27: 553.
- MAGILL, R. E. & SCHELPE, E. A., 1979. The bryophytes of Southern Africa. An annotated checklist. *Mem. bot. Surv. S. Afr.* No. 43, pp. 38.
- MOLL, E. J., MCKENZIE, B., MCLACHLAN, O. & CAMPBELL, B. M., 1978. A mountain in a city—the need to plan the human usage of the Table Mountain National Monument, South Africa. *Biol. Cons.* 13: 117–132.
- MORRIS, J. W., 1978. Botanical research in perspective—terrestrial ecology. *S. Afr. J. Sci.* 74: 236.
- MORRIS, J. W., 1979. Review: Multivariate analysis in vegetation research. Second enlarged edition by L. Orlóci. *Bothalia* 12: 760.
- MORRIS, J. W. & GLEN, H. F., 1978. PRÉCIS the National Herbarium of South Africa (PRE). Computerised Information System. *Taxon* 27: 449–462.
- NESER, S. & FUGLER, S. R., 1978. Silky Hakea. In C. H. Stirtion, *Plant invaders—beautiful but dangerous* pp. 76–79. Cape Town: Dept. of Nature & Environmental Conservation of the Cape Provincial Administration.
- OBERMEYER, A. A., 1979. *Aloe macleayi*. *Flower. Pl. Afr.* 45: t. 1789.
- OBERMEYER, A. A., 1979. A new species of *Gladiolus* from the Transvaal. *Bothalia* 12: 636.
- OBERMEYER, A. A. & BOGNER, J., 1979. *Gonatopus rhizomatosus*. *Flower. Pl. Afr.* 45: t. 1782.
- OLIVER, E. G. H., 1978. Review: The South African Acacias by J. D. Carr. *Bothalia* 12: 577.
- RETIÉF, E. & FINKELSTEIN, N., 1979. The correct name for *Fagara ovatifoliolata*. *Bothalia* 12: 637.
- ROSS, J. H., 1979. Notes on *Prosopis* in southern Africa. *Bothalia* 12: 635.
- RUTHERFORD, M. C., 1979. Aboveground biomass subdivisions in woody species of the Savanna Ecosystem Project study area, Nylsvley. *S. Afr. Nat. Sci. Prog. Rep.* 36: 1–33.
- RUTHERFORD, M. C., 1979. Allometric biomass relations applied to succulent plant forms. *Bothalia* 12: 737.
- RUTHERFORD, M. C. & KELLY, R. D., 1978. Woody plant basal area and stem increment in *Burkea africana*—*Ochna pulchra* Woodland. *S. Afr. J. Sci.* 74: 307–308.
- SCHEEPERS, J. C., 1979. Review: Biogeography and ecology of Southern Africa. (Monographiae Biologicae Vol. 31) edited by M. J. A. Werger. *Bothalia* 12: 761–762.
- SNOOK, L. & STIRTION, C. H., 1979. Naturalized *Agrostis* in South Africa: *Agrostis avenacea* and *A. montevidensis*. *Bothalia* 12: 637.
- STIRTION, C. H., 1978. *Lantana camara* L. In C. H. Stirtion, *Plant invaders—beautiful, but dangerous* pp. 88–91. Cape Town: Dept. of Nature & Environmental Conservation of the Cape Provincial Administration.
- STIRTION, C. H., 1978. *Nerium oleander* L. In C. H. Stirtion, *Plant invaders—beautiful, but dangerous* pp. 100–103. Cape Town: Dept. of Nature & Environmental Conservation of the Cape Provincial Administration.
- STIRTION, C. H., 1978. *Nicotiana glauca* Grah. In C. H. Stirtion, *Plant invaders—beautiful, but dangerous* pp. 104–107. Cape Town: Dept. of Nature & Environmental Conservation of the Cape Provincial Administration.
- STIRTION, C. H., 1978. Plant invaders: a threat to the flora of the Cape Province. In C. H. Stirtion, *Plant invaders—beautiful, but dangerous* pp. 28–29. Cape Town: Dept. of Nature & Environmental Conservation of the Cape Provincial Administration.
- STIRTION, C. H., 1978. The vegetation of the Cape Province. In C. H. Stirtion, *Plant invaders—beautiful, but dangerous* pp. 12–27. Cape Town: Dept. of Nature & Environmental Conservation of the Cape Provincial Administration.
- STIRTION, C. H., 1978. Why are plant invaders so successful? In C. H. Stirtion, *Plant invaders—beautiful, but dangerous* pp. 36–37. Cape Town: Dept. of Nature & Environmental Conservation of the Cape Provincial Administration.
- STIRTION, C. H., 1978. Why is the flora of the Cape Province worth saving? In C. H. Stirtion, *Plant invaders—beautiful, but dangerous* pp. 38–39. Cape Town: Dept. of Nature & Environmental Conservation of the Cape Provincial Administration.

- STIRTON, C. H. & GORDON-GRAY, K. D., 1978. The *Eriosema cordatum* complex 1. The *E. populifolium* group. *Bothalia* 12: 395-404.
- STIRTON, C. H., & NESER, S., 1978. Control of plant invaders. In C. H. Stirton, *Plant invaders—beautiful, but dangerous* pp. 144-148. Cape Town: Dept. of Nature & Environmental Conservation of the Cape Provincial Administration.
- STIRTON, C. H., & TRAINOR, H. M., 1978. How you can help control plant invaders. In C. H. Stirton, *Plant invaders—beautiful, but dangerous* pp. 154-156. Cape Town: Dept. of Nature & Environmental Conservation of the Cape Provincial Administration.
- TAYLOR, H. C., 1978. *Albizia lophantha* (Willd.) Benth. Stink-bean. In C. H. Stirton, *Plant invaders—beautiful, but dangerous* pp. 64-67. Cape Town: Dept. of Nature & Environmental Conservation of the Cape Provincial Administration.
- THOMPSON, M. F., 1979. Studies in the Hypoxidaceae III. The genus *Pauridia*. *Bothalia* 12: 621-625.
- TÖLKEN, H. R., 1979. Review: Flora Zambesiaca. Volume 4. *S. Afr. J. Sci.* 75: 142.
- TÖLKEN, H. R., 1979. A re-evaluation of the *Cotyledon orbiculata* Complex. *Bothalia* 12: 615-620.
- TÖLKEN, H. R., 1979. Three new taxa and a new combination. *Bothalia* 12: 633-634.
- TÖLKEN, H. R. & WIENS, D., 1979. A new species of *Tapinanthus* (Loranthaceae). *Jl S. Afr. Bot.* 45: 223-225.
- VAN DER MEULEN, F., 1979. Plant sociology of the western Transvaal Bushveld, South Africa: a syntaxonomic and synecological study. *Dissert. Bot.* 49: 1-192. Lehre: J. Cramer.
- VAN DER MEULEN, F., MORRIS, J. W. & WESTFALL, R., 1978. A computer aid for the preparation of Braun-Blanquet tables. *Vegetatio* 38: 129-134.
- VAN DER MEULEN, F. & WESTFALL, R. H., 1979. A vegetation map of the western Transvaal Bushveld. *Bothalia* 12: 731-735.
- VERDOORN, INEZ C., 1979. *Aloe corallina*. *Flower. Pl. Afr.* 45: t. 1788.
- VORSTER, P., 1979. A note on *Mariscus sumatrensis*. *Bothalia* 12: 634.
- VORSTER, P., 1979. Review: Praktiese plant sistematiek deel I: Die kriptogame deur A. Eicker, M. I. Claassen, W. F. Reyneke en N. Grobbelaar. *Bothalia* 12: 760.
- WEISSER, P. J. & MARQUES, F., 1979. Gross vegetation changes in the dune area, between Richards Bay and the Mfolozi River, 1937-1974. *Bothalia* 12: 711-721.
- WELLS, M. J., 1978. History of control of plant invaders. In C. H. Stirton, *Plant invaders—beautiful but dangerous* pp. 149-153. Cape Town: Dept. of Nature and Environmental Conservation of the Cape Provincial Administration.
- WELLS, M. J., 1978. *Stipa trichotoma* Nees. In C. H. Stirton, *Plant invaders—beautiful but dangerous* pp. 140-143. Cape Town: Dept. of Nature & Environmental Conservation of the Cape Provincial Administration.
- WELLS, M. J., 1978. What is a weed? *Environment RSA* 5 (11): 6-7.
- WELLS, M. J., 1978. A note on *Fagus sylvatica* var. *purpurea*. *Forestry News* 4 (78): 6-7.
- WELLS, M. J., 1979. Review: Pennington's Butterflies. *South African Weed Science Society, Newsletter* 3.
- WELLS, M. J., 1979. The flora of the Pretoria area. *Environment RSA* 6 (4): 3-4.
- WELLS, M. J., 1979. The rôle of economic botany in the development of South Africa. *Bothalia* 12: 751-754.
- WELMAN, W. G., 1979. Review: Compositae in Natal by O. M. Hilliard. *Bothalia* 12: 760-761.

Book Reviews

THE FLORA CAPENSIS OF JAKOB AND JOHAN PHILIPP BREYNE edited by MARY GUNN and ENID DU PLESSIS. *Johannesburg: Ad. Donker for the Brenthurst Press*. 1978. Pp. 218, 255 × 265 mm, 90 colour plates. Edition limited to 1 000 copies of which 25 were bound in full leather, 125 in half leather at R225 each and 850 in cloth as the standard edition at R85 each.

The publication of a book on any aspect of the South African flora is an event to be welcomed by both botanist and plant enthusiast alike, as such a book, particularly with colour illustrations, is bound to win an appreciation of our fascinating and unique flora. The last few decades have seen many such books appear, which now grace the bookshelves of Africana collectors, botanists and plant enthusiasts, but none, in my opinion, can be compared with the one under review.

During the 17th and 18th Centuries artists painted and made collections of paintings of Cape flowers. Some of the collections found their way into libraries of eminent and wealthy people in Europe and aroused keen interest in the flora of the Cape "that inexhaustible storehouse of botanical riches" (Lodiges). This resulted in a number of published works depicting some of these paintings. Amongst these works was that of Jakob Breyne of Danzig and his son Johan Philipp. A collection of colour paintings of Cape flowers was acquired by Jakob Breyne some time before his death in 1697, and his son had them bound in book form in 1724 entitling it *Flora Capensis*. This book must have passed to many owners and was eventually acquired by Sir Ernest Oppenheimer in 1959 for his own Brenthurst Library. The current owner, Mr Harry Oppenheimer, has said "I have been concerned to share some of the library's unpublished Africana with a wider audience. Hence my decision, five years ago, to support the creation of the Brenthurst Press. If its productions make other people as happy as they do me, then I am not going to grumble about its cost" (S.A. Panorama, June 1979). The Breyne's *Flora Capensis* is the fourth in the series emanating from the Brenthurst Press and was edited for them by Miss Mary Gunn, formerly Librarian of the Botanical Research Institute, and Mrs Enid du Plessis of the C.S.I.R.

The title '*Flora Capensis*' as given by the Breyne's is somewhat of a misnomer as the volume is a florilegium (collection of paintings of flowers) with no text in the style of a flora. The editors have therefore given a detailed account of the background to the work with a most interesting introduction dealing with florilegia and the early artists and botanists who were or may have been associated with them. Then there is a most valuable chapter on the life and works of the Breyne's, father and son, followed by another chapter giving the details about the Brenthurst florilegium with comparisons of almost identical florilegia in the libraries of the Botanical Research Institute, Oxford and Leiden. This text covers 31 pages; included in it are some reference plates, the title page of the original *Flora Capensis*, and a photograph of Jakob Breyne taken from the Prodomi of 1739 published by Johan Philipp Breyne.

The text is followed by the reproduction of the 85 coloured folios of the *Flora Capensis* florilegium rearranged by the editors. Each plate is accompanied by some brief notes about the species depicted. Here I would have liked to see much more useful information such as typification where relevant to the Breyne's works. After the paintings there is a section on selected biographies of persons mentioned in the text, notes on cited references, and an exhaustive bibliography. One would have hoped for an index, but reference has to be made to the numerical listing of the plates right at the beginning of the work.

The first thing that strikes one is the quality of production. The imported paper gives that extra touch of quality. One glance at the last page of the book where full details of the paper, printing and binding are given, a rarity in publishing, shows that this is a book with a difference; but one difference I found most disconcerting was the format.

The 'modern' format seems unsuited to the reproduction of an old work. The 'trimmed' frontispiece and several plates and the shape of the reproduced title-page look rather out of place. After a study of the list of plates one finds that just over half of the plates had to be altered in size to fit the format of reproduction. This I find disappointing in a quality reproduction.

It seems to be a general practice that reviewers of books should show their diligence of examination by quoting printing errors. This I would not readily have wished to do with this book, being far more interested in the subject, but realizing that it is a quality production and an expensive one I was most surprised to find a number of printing and even manuscript errors. Spelling mistakes occurred as, for example, *Hessia* for *Hesse* (Pl. 13), *Penaceae* for *Penaeaceae* (Pl. 53), *pedicles* (Pl. 17), *corns ovid* (Pl. 39), *O. Stopf* for *O. Stapf* (p. 215) and *Plunkenet* twice on p. 217. Some bad proof-reading

occurred on Pl. 62 where the caption "this is not a Cape plant" is misplaced and on Pl. 78 where the lower two captions are reversed. Some oddities are "medical" instead of "medicinal" properties, "lightly packed" instead of "tightly packed" (Pl. 55) and sentences such as "collected by Carl Thunberg at the Cape in 1772; this plant was also described by Linnaeus" (Pl. 37), or "in the south-western Cape and as far north as Port Elizabeth" (Pl. 51). One botanical statement I disagree with, occurs on Pl. 9 concerning *Lachenalia contaminata*, a common lowland species: "The leaves only appear when the flowers are fully open and sometimes only when the flowers are already going to seed." The situation is exactly opposite. The leaves have mostly died down and even disappeared by the time the plants have come into flower which is in early summer when the moist habitat has completely dried out. These are minor matters and enough has been said.

One could argue about some of the determinations, but then in the difficult cases of the Group B paintings this may be a matter of opinion. One real error is in the only non-Cape plant depicted on Pl. 69 which is definitely not *Orchis* sp. but *Ophrys fusca*.

A number of papers has been published on some of the early florilegia of Cape flowers notably the Codex Witsenii and Codex van der Stiel and the 'originals' from which authors like the Breyne's, Burman, Boerhaave, Petiver, Plukenet, and Tachard obtained their engravings. The editors of the Breyne's *Flora Capensis* have added yet another puzzle, not hitherto known to recent botanists, to the bibliographical problems. Frequent mention is made by the editors to the florilegium in the Botanical Research Institute. This bound volume was most fortunately acquired by Miss Gunn in 1949 for the Botanical Research Institute.

This work aroused in me a fascination for these early florilegia and a desire to examine and compare the originals of as many as I could. This resulted in some interesting observations, which have been gathered into a short article published elsewhere in this journal (pp. 115-125).

The Brenthurst Press must receive a sincere vote of appreciation for making this work available and the editors must be thanked for their part in the production of this very fine work. They have done a great service to botany in South Africa. The very high price of the book will unfortunately confine it to Africana collectors and to libraries where botanists will be able to consult it for references to early botanical history and taxonomy.

E. G. H. OLIVER

PENNINGTON'S BUTTERFLIES OF SOUTHERN AFRICA. Ed. C. G. C. DICKSON with the collaboration of D. M. KROON. *Johannesburg: Ad. Donker*. 1978. Pp. 670, 198 colour plates, 1 map. Price R51.00.

Not since D. A. Swanepoel's 'Butterflies of South Africa' (1953), which included 474 species, has there been an attempt to illustrate and treat all the butterflies of South Africa in a single volume. It is sixteen years since the last volume of the late Dr George van Son's uncompleted taxonomic treatise 'The Butterflies of Southern Africa' (1949-1963) appeared, and there has been a great need for an up to date coverage of the butterflies of the whole sub-region to provide a platform for further entomological work, to stimulate inter-disciplinary research and as a tool for ecosystem studies.

'Pennington's Butterflies of Southern Africa' includes 780 species—all the species recorded from Africa south of an imaginary line drawn from the Cunene River in the west to the Zambezi River in the east. Each species is illustrated and has a short text covering aspects such as: distribution, whether the species is single, double or continuously brooded, flying times, foodplants and feeding habits. The result is a fine (if pricey) book that will be of great value, not only to entomologists, but also to botanists, pollination biologists, production ecologists, weed scientists and conservationists.

This is not a taxonomic treatise, it does not include taxonomic descriptions or drawings of genitalia, but great attention has been paid to characters that separate closely allied species and this, together with the scope and excellence of the illustrations make Pennington's Butterflies the layman's ultimate guide to the identification of the butterflies of the sub-region via wing-markings.

At best (e.g. no. 29) the plates are superb, but in some (e.g. no. 126) the blue background is too harsh and competitive—an aesthetic drawback that does not affect the usefulness of the plates. I cannot see these plates easily being bettered, and for this reason alone 'Pennington's Butterflies' will remain a standard reference work for very many years.

My chief criticisms of the text are: the retention of outdated plant names (rectified in the foodplant list); and the excessive use of abbreviations for butterfly genera e.g. 'A' for *Aloides*. In large genera one may have to turn back 25 pages in order to find the genus heading (which could have been repeated at the top of each text column). This criticism extends to the foodplant list where the combination of genus abbreviations and lack of page references is annoying, and forces one to match up genus abbreviations and species names in the general index, in order to find page references to the relevant text.

The distribution records cited are somewhat scanty and, in the absence of distribution maps, no clear picture of species distributions emerges. In the case of rare species needing protection this is not only understandable but commendable. In other cases it is trying and I feel that small distribution maps to give a generalized picture of distribution at a glance would have been a great asset, although adding considerably to the bulk and cost of an already substantial volume.

If the species accounts are somewhat spartan, there is compensation to be found in specialist chapters. For those interested in production studies and in host/predator relationships the full set of life-history paintings of the Hesperiid (skipper) butterflies by the late Mr Gowan Clark have been included and full text references are given to published life-histories of other South African butterflies. There is a chapter on the intricate relationships between butterfly larvae, ants and other insects, and plants (including fungi and lichens)—a necessary reminder that we have to do with complicated ecosystems, not simple plant/insect relationships.

The fine mimicry by butterfly larvae and pupae of their host plants, provides mute evidence of their long history of association. Botanists will be interested in the incidence of endemism and in parallels in distribution between butterflies and vegetation areas such as the S.W. Cape, the Karoo and the eastern coast-belt (with tropical affinities).

The list of known foodplants of butterfly larvae, compiled by Dr D. M. Kroon, is far more comprehensive than anything previously available. It contains the names of over 400 plants—the foodplants of well over half the butterfly species of the sub-region. The list enables one to pick out those, usually the rarer species that have only a single foodplant, those such as some of the *Papilio* spp. that have a number of foodplants (often restricted to a plant genus or family) and those plants that are host to a number of butterfly species e.g. there are 9 species recorded as feeding on *Acacia karroo*, whilst 34 species (from 9 genera) have been recorded on the grass *Ehrharta erecta*.

There are some omissions e.g. *Cryptocarya latifolia* recorded as a foodplant of *Papilio euphranor* (in the J. Ent. Soc. S.Afr. 20: 117), and *Gymnema sylvestre* mentioned on p. 34 of 'Pennington's Butterflies' do not appear in the list. There are also some errors, such as that resulting from the omission of the family name Polygonaceae, one line below Polygalaceae on p. 633; the mis-spelling of *spicaeformis*, which should read *spiciformis* on p. 610; the mis-spelling of *ruwenzorensis*, which should read *ruwensorensis* on p. 613; and there are inconsistencies in the endings of specific epithets especially those taken from the names of persons, but on the whole the list is conspicuously free of gremlins.

Criticisms aside, I cannot see 'Pennington's Butterflies' being improved on as a general reference work for many years and with so many habitats and species being threatened this book must also (unfortunately) fall into the category of 'instant Africana'.

M. J. WELLS

MOUNTAIN SPLENDOUR. WILD FLOWERS OF THE DRakensBERG by R. O. PEARSE. Cape Town: Howard Timmins. 1978. Pp. 239 with c. 400 colour photographs. Price R20, 00.

For one who, as a young botanist almost straight from university was sent in 1950 on transfer to Cathedral Peak Forest Station in a rather reluctant Willys Americar to carry out a botanical survey for the Department of Forestry, who found himself perched alone in a wooden cottage on the Little Berg without furniture and with only a few tins of canned food, kilometres from any human habitation and with only the baboons and antelopes as neighbours, and who initially viewed the Drakensberg scene with a somewhat jaundiced and lonely eye, but who in time came to love the mountains and their flora, returning again year after year, it is a pleasure to review Mr Pearse's book, "Mountain Splendour".

The foreword to the book is fittingly contributed by the late Professor A. W. Bayer, who also edited the text. It is largely due to the encouragement and interest of Professor Bayer that the flora of the Drakensberg is as well known as it is to-day.

In his introduction Mr Pearse outlines the object and scope of the book. He then deals with the topography and climate, fires, plant nomenclature, Zulu medicinal usages, African names and finally the Natal Wild Flower Protection Ordinance.

Preceding the text proper is a double page colour photograph of a branch of *Halleria lucida* with red, rain- and light-dappled flowers. The caption to the photograph is a quotation from Rupert Brooke's well-known poem, "The Great Lover", in which he describes the things he has loved. The photograph and caption, to me, set the tone for what is to follow, namely an intimate look at some of the most common and striking plants of the 'Berg, photographed with technical skill and artistry and written in impeccable prose. At the same time the work, with minor exceptions, is botanically correct. And through it all, Mr Pearse's great love of the flowers of the Drakensberg is clearly evident.

The species are dealt with under family and genus. Mr Pearse describes all three taxa briefly and informally and gives the derivation of their names. He records any information of special interest concerning the plants and mentions their medicinal uses. Mostly Mr Pearse has used old family names (sanctioned by long usage), for example Compositae (Asteraceae), Labiatae (Lamiaceae) and Leguminosae (Fabaceae), but surprisingly has used the "new" alternative family name Clusiaceae for Guttiferae.

On p. 166 he explains that *Plectranthus calycinus* has been transferred to *Rabdosia*, but states that in this instance it has been thought better to include it in the genus *Plectranthus*. In fact, although he includes it under the heading *Plectranthus*, he consistently refers to it by its correct name *Rabdosia calycina*. It would have been preferable to include it under a separate heading *Rabdosia*.

On p. 140 Mr Pearse writes that the derivation of the name *Hypericum* is uncertain. Dr N. K. B. Robson of the British Museum, world authority on *Hypericum* and co-author with the reviewer of the revision of *Hypericum* in the Flora of Southern Africa, considers that the name is derived from the Greek name for St John's Wort, viz. hypereikon, i.e. hyperei + kon = above and image. The Greeks used plants of this genus to decorate religious images in order to ward off evil spirits, especially around midsummer's eve (St John's eve).

On a few occasions Mr Pearse's names are out of date. For example, most authorities now regard *Vellozia viscosa* as a species of *Xerophyta* and *Vellozia elegans* as *Talbotia elegans*. Mr Pearse is aware of these changes, but has not accepted them. *Buddleia* (p. 154) is now *Buddleia* following the new Code (1978) and *Buddleia corrugata* is now *B. loricata*.

Much more could have been written about *Helichrysum tenax*. This plant grows up to 2 m high (not about 1 m high) and from a distance bears a striking resemblance to the arborecent Senecios of East African mountains. It usually grows along streambanks and in fynbos, but when there is man-made disturbance such as road construction, it is often dominant in the resultant rock rubble, e.g. Mike's Pass at Cathedral Peak Forest Station in the 1950's. Mr Pearse mentions that the plant has sticky leaves. This is certainly true and led to speculation in Natal newspapers many years ago that the plant was insectivorous which, of course, it is not. While on the subject of *Helichrysum*, it should be pointed out that apart from a different flowering time, *H. tenuifolium* may be distinguished from *H. trilineatum* by its greater stature (plants up to 2 m high) and the usually narrower leaves.

On p. 192 Mr Pearse discusses the derivation of the specific epithet of *Pentania prunelloides* and correctly states that it refers to the resemblance of the plant to *Prunella* of the Lamiaceae. He then remarks on the coincidence that there is a Latin word *pruna* meaning "pertaining to fire" and that the Afrikaans name of *P. prunelloides* is Sooi-brandbossie and the Zulu name i-Cimamllilo, "to put out the fire". However, this is mere coincidence. The Africans in the 'Berg use the roots to "put out the fire" in their stomachs, while the Afrikaans name Sooi-brandbossie meaning "heartburn shrublet" suggests a similar use. The derivation of *Pentania*, which Mr Pearse is not sure about, is straightforward: it comes from the Greek words for five and unequal in reference to the "five very unequal corolla segments of the flowers" (Wittstein, 1856).

On p. 51 I had to rub my eyes to see whether they were registering correctly. The excellent photograph of *Sandersonia aurantiaca* which many regard as the most beautiful flower in Natal, bears the caption *Littonia modesta* and vice versa. As an editor of botanical journals, only too familiar with printing gremlins, I sympathize with Mr Pearse. Thirty-five pages later, I rubbed my eyes again: the "mystery flower", which Mr Pearse refers to and which the experts cannot identify with any certainty, is labelled *Watsonia densiflora*! Another error is on p. 69: *Vellozia elegans* (fig. 3) is really *Aristea cognata*.

At the risk of being labelled a one-track botanist, who has no time for exotics, I query the inclusion of a weed such as *Phytolacca octandra*, which I find ugly, however well photographed. *Bidens formosa*, Cosmos, is also a weed, but it is so attractive a plant of the Drakensberg lowlands in autumn that its inclusion is understandable. Personally I would have preferred to see some of the elegant 'Berg grasses' included.

I would like to voice a criticism that applies to many authors (including Mr Pearse) of popular and semi-popular books on natural history in South Africa, and that is the failure to acknowledge information obtained from other published works usually of a scientific nature. Scientists are obliged to acknowledge in the text and in the list of references at the end of their papers, information obtained elsewhere. It may be argued that frequent reference citations in the text of popular books would interrupt the smooth flow of the written word. This may be true, but it would be quite acceptable and certainly courteous to mention sources in the Acknowledgements.

In conclusion, "Mountain Splendour" is a well-written and beautifully illustrated book which is a must for all lovers of the Drakensberg flora. The book is well-presented, the paper is of excellent quality and the colour-reproduction is superb. The pencil sketches by Muriel Zonneveld of individual flowers and the mountains add to the charm of the book. The slightly larger than A4 format makes the book more suitable for the coffee table than the field. I am sure that readers of Bothalia will enjoy the book as much as I did.

D. J. B. KILLICK

PLANTKUNDE: ANATOMIE EN FISILOGIE by N. GROBBELAAR, P. J. ROBERTSE, J. V. VAN GREUNING & J. H. VISSER. *Durban: Butterworth*. 1979. Pp. 182, figures numerous. Price R6,95.

This plant anatomy and physiology booklet is one of a series of five Afrikaans language botany text-books designed specifically for first-year university students, especially those with virtually no biological background at all. The authors—all members of staff of the Department of Botany at the University of Pretoria—and the publishers, are to be congratulated on effectively achieving their stated objective with a product which compares very favourably with any comparable English language work.

This book is neatly but not extravagantly produced and, being soft-covered, should be within the means of the average student, bearing in mind that a set of five is required to fully cover the first year botany course. The design is modern and the layout is clear and uncluttered with the grey chapter title pages being easy to locate. Each chapter is also preceded by a relevant and concise summary of the study objectives of the ensuing chapter. The 173 pages of Afrikaans text are easy to read and yet comprehensive and even beginners should readily comprehend and assimilate the contents and to the English speaker it will serve as an extremely useful introduction to Afrikaans terminology and spelling! All figures and photographs are original and a truly refreshing innovation is the use of examples drawn from our indigenous South African flora wherever possible. The printing of the excellent photomicrographs is adequate and all details referred to are clearly visible. Indeed, a book of this nature virtually makes a teacher redundant and to my mind this text-book is ideal for correspondence courses.

This handy series undoubtedly fulfills a very real need in our particular South African context—to provide a basic botanical text-book for Afrikaans-speaking students requiring botany as an ancillary course in their university curricula. This text-book is, therefore, more than adequate for a first, and only, course in plant anatomy and physiology for medical, veterinary and agricultural students. I am sure that the authors have directed this book primarily at this category of student which undoubtedly comprises the bulk of university first year botany enrolment and includes many students with little or no botanical background. However, if the training of professional botanists in South Africa is to be upgraded, this booklet must be seen only as a sound foundation for the first course in a three-year biology degree but needs to be supplemented at least by further practical courses in techniques and applied aspects. Obviously the authors have had to contend with shortcomings in our educational system in this respect, but perhaps it is opportune to propose here that matriculation biology (as well as physical science and mathematics) be made a prerequisite for acceptance to a biological degree at South African universities just as science and mathematics are minimum requirements for chemistry and physics majors. To have to bring beginners up to matric level in the first year leaves an insurmountable teaching load for the second and third years.

In common with most other botanical text-books, I feel that the applications of plant anatomical and physiological informa-

tion, in fields other than basic, theoretical botany, are not sufficiently stressed. To the young, unenlightened student, plant anatomy and physiology must still appear as isolated, unintegrated, academic subjects. For students not intending to major in botany the use of anatomical and physiological knowledge in solving everyday problems in disciplines other than botany would be stimulating and of possible benefit in their future careers. The inclusion of D. F. Cutler's Applied Plant Anatomy in the lists of suggested further reading at the end of each chapter in the anatomy section would have overcome this shortcoming to a certain extent. Cutler's book, together with the book under review, complement each other and together would help stimulate student interest in anatomy and assist students in relating to the subject.

Very few minor errors were detected although Fig. 5.5 C is definitely not a transverse section of a *Cynodon* sp. leaf. This is a thorough and well-balanced book and appears assured of the success it definitely deserves.

R. P. ELLIS

PLANTKUNDE: GENETIKA EN KRIPTOGAME deur A. EICKER, M. I. CLAASSEN, W. F. REYNEKE EN N. GROBBELAAR. 1979. *Durban: Butterworth*. Bladsye 157. Prys R6,95.

Hierdie boek is een van 'n reeks van vier boeke wat gepubliseer is met die doel om eerstejaarplantkundestudente met hulle studies te help. Die werk word eenvoudig uiteengesit sodat iemand met geen biologiese agtergrond dit ook kan verstaan. Die studietoelstellings aan die begin van elke hoofstuk lei die eerstejaarstudent sodat hy na elke hoofstuk, deur selftoetsing, kan bepaal of hy op 'n sinvolle wyse daaraan verantwoording kan doen.

Genetika

Die eerste hoofstuk is bondig en sistematies uiteengesit, sodat die leerstof vinnig en maklik bemeester kan word. Elke meiosestadium se belangrikste kenmerke kon miskien net puntsgewys aangestip gewees het, wat die instudering daarvan sou bespoedig. Elke stadium in meiose is goed beskryf, alhoewel hier en daar belangrike kenmerke bygevoeg kan word. In die beskrywing van leptoteen kan genoem word dat die kernmembraan teenwoordig is en dat die nukleolus baie prominent is gedurende hierdie stadium.

Sinne soos "diploïede organismes het twee stelle chromosome in elke sel" (bl. 5), kan miskien tot verwarring lei by die student wat nog geen ondergrond in biologie gehad het nie. Dit sou duideliker wees om te sê: "Diploïede organismes het twee stelle chromosome in elke somatiese sel (liggaamsel)", wat geslag-selle dus uitsluit.

In Fig. 1.2 sal 'n paar veranderinge dit dalk meer duidelik maak. Die nukleolus kan sê geteken word dat dit verklein in elk daaropvolgende profase I—stadia—vanaf sigoteen totdat dit uiteindelik verdwyn wanneer metafase I bereik word. In die figuur kan die terminalisasie van die chiasmata gedurende diakinese duideliker geïllustreer word, sodat daar gesien kan word dat die chiasmata neig om na die eindpunte van die bivalente te beweeg om aan die bivalent (gedurende diakinese), sy kenmerkende ronde voorkoms te gee. In dieselfde figuur sou dit 'n baie helderder beeld aan die eerstejaarstudent gee as die terminalisasie van die chiasmata gedurende diakinese sodanig aangedui word, dat die nuwe chromatiedsegmente wat ontstaan het as gevolg van die breking in die chromatiede en gevolglike uitruiling van chromatiedsegmente, aangetoon word. 'n Inlaskets ter illustrering sou miskien die geskikte wees.

Gedurende metafase I van Fig. 1.2 kan die skets die feit dat die chiasmata van die bivalente op die ekwatoriaalplaat lê en die sentromere georiënteer in die rigting van die teenoorgestelde pole aan beide kante van die ekwatoriaalplaat, duideliker aangetoon het. Hierdie sal dan ook aan die eerstejaarstudent die verskilpunt van metafase I van meiose en metafase van mitose (waar die sentromere op die ekwatoriaalplaat lê), helderder na vore bring en uitlig. Twee verskillende vorms van bivalente kon ook aangetoon word. Byvoorbeeld 'n ringvormige bivalent (by die metasentriese chromosome), waar chiasmata in beide arms van die chromosome plaasgevind het en 'n staafvormige bivalent, wat kon ontstaan het by die akrosentriese chromosome waar chiasmata in die langer arm van die bivalent kon plaasgevind het. Dié voorstelling behoort die leerstof vir die eerstejaarstudent duideliker uit te spel. Verder kan die onderskrif van die figuur vir volledigheid lui: "Die verskillende stappe van meiose by 'n organisme met 2 pare chromosome ($2n=4$)."

By die beskrywing van anafase I van meiose kan spesifiek gewys word op die belangrike verskilpunt met mitose. Dit is, dat gedurende anafase I van meiose geen deling van die sentromere plaasvind soos by anafase van mitose nie, maar slegs 'n skeiding van 'onafhanklike sentromere.

Daar is op 'n eenvoudige en insiggewende wyse verduidelik watter belangrike bron van variasie die anafaseskeiding van meiose I onder die nageslag meebring. Die skrywers het 'n baie goeie beskrywing en verduideliking van Mendel se wet van segregasie en rekombinasie, asook die wet van onafhanklike sortering weergee. Koppeling en uitwisseling is baie goed aan die hand van baie duidelike sketse aangebied en dit geld ook vir die beskrywing en diagramme oor die tipe kruisings wat gedoen kan word om bepaalde genotipiese en fenotipiese verhoudings in die F_2 -generasie te verkry.

Hierdie hoofstuk beantwoord op 'n kort, eenvoudige en interessante wyse aan die voorafgestelde studietoelstellings. Enige eerstejaarstudent behoort, nadat hy hierdie hoofstuk deurgewerk het, die teks baie goed te begryp en sy studietoelstellings sinvol te kan weergee. Die leerstof word op 'n stimulerende wyse oorgedra en is deurspek met interessantheite wat die leser tot verdere opleeswerk behoort aan te vuur. Deur gebruik te maak van die voorgestelde 8 boeke as aanvullende leesstof, is die inhoud van hierdie hoofstuk baie deeglik gedek.

Ongelukkig is daar 'n drukfout in die teks op bl. 21. Die letters C en c moet vervang word met G en g.

Kriptogame

Die verskillende terme word kortliks verduidelik en in die meeste gevalle word dit verder met uitstekende diagrammatiese voorstellings, deurstraal-aftelektronmikrograwe of fotomikrograwe soos veral in die geval van die alge, toegelig. Ongelukkig word geen skaal by enige van die elektronmikrograwe of fotomikrograwe aangegee nie. Die student het dus geen begrip van die grootte van die organisme nie. Byskrifte by die mikrograwe ontbreek, sommige is selfverduidelikend, terwyl by ander, soos byvoorbeeld in die geval van die Bryophyta dit nie so is nie. In sommige gevalle van die Bryophyta-mikrograwe word die leser egter verwys na vorige figure vir die byskrifte. Hierdie mikrograwe is eintlik 'n herhaling van dieselfde struktuur.

As gevolg van die bondigheid van die inhoud word daar soms opmerkings gemaak wat die verkeerde inligting weergee, byvoorbeeld die alge word in ses afdelings verdeel, maar daar is geen verklaring waarom die Cryptophyta nie ingesluit word nie. Volgens die inhoud van die boek is algeselle of naak of dit besit 'n selwand wat in die meeste gevalle uit twee lae bestaan. Geen melding word gemaak van die ander tipe selomhulsels soos skubbe of lorikas wat 'n belangrike rol speel in die identifikasie van wiere nie.

Die boek voorsien in 'n behoefte wat daar bestaan het en sal van groot nut vir enige eerstejaarstudent wees. Aangesien die strukture en lewenssiklusse van hierdie laer groepe so goed uiteengesit word, word daar gehoop dat meer studente geïnspireer sal word om hierdie organismes te bestudeer—'n saak wat in die verlede grootliks verwaarloos is.

W. GAUM en R. GLEN

PLANTKUNDE: ORGANOGRAFIE EN SITOLOGIE deur W. F. REYNEKE, L. A. COETZER en N. GROBBELAAR. *Durban: Butterworth*. 1979. 133 bladsye. Prys R6,95.

Hierdie publikasie, wat handel oor die organografie en sitologie van die Anthophyta (Blomplante), verteenwoordig een van 'n reeks van vier teoretiese en een praktiese handleiding wat deur die personeel van die universiteit van Pretoria, vir die gebruik van eerstejaarplantkundestudente, geskryf is. 'n Student het nie matriek onderrig in biologie nodig om hierdie boek te verstaan nie. Die geskiedkundige sitologiese agtergrond neem die student kortliks deur 'n historiese toer vanaf die baanbrekerswerk, gedoen deur vroeëre wetenskaplikes, met behulp van hulle eenvoudige lense, tot die waarneming van die gedetailleerde ultrastruktuur van selle met behulp van verbetering in resoluiekrag, wat verkry is met die elektronmikroskoop.

Die teks is duidelik uiteengesit met goeie taalgebruik en is maklik leesbaar en nie te tegnies van aard nie. Vetgedrukte letters word deurgaans gebruik om sleutelwoorde vir die student te benadruk en aan die begin van elke hoofstuk word studietoelstellings ook weergegee wat aan die studente 'n geleentheid skenk om spoedig sleutelwoorde te noteer en derhalwe hom in die regte rigting te lei. Aanvullende leesstof word aan die einde van elke hoofstuk aangedui en bied aan die student 'n wye spektrum van inligtingsbronne wat geraadpleeg kan word indien verdere inligting verlang word. Die sistematiese en logiese wyse van aanbieding is stimulerend vir studietoelstande.

Die boek bevat goeie illustrasies wat deur middel van foto's asook diagrammatiese voorstellings die teks breedvoerig toelig. Byvoorbeeld, die gepaarde membrane van die golgi-apparaat en endosplasmiese retikulum is goed waarneembaar aangebring en die funksie van die ribosome word met behulp van 'n skets geïllustreer wat die verduideliking in die teks in 'n neutropo aanvul. Vir duidelikheid oor die morfologie van 'n chromosoom in, byvoorbeeld, laat profase, kon 'n skets met byskrifte egter ingesluit gewees het sodat terme soos chromatied, suster-chromatiede en half-chromatiede geïllustreer kon word. Wat die weergawe van foto's betref, dien daarop gelet te word dat wado foto's sekere voorbeelde uitbeeld, elkeen duidelik is om sodoende die leser 'n goeie idee van die onderwerp te laat vorm.

Die ordelike, voortreflike, bondigheid en interessantheid van aanbieding is treffend, sodat dit op 'n aangename wyse deur 'n student geabsorbeer kan word. Om verwarring te voorkom kon 'n paar punte egter duideliker gestel word. By anafase kon die sametrekking van die spoelrade in die rigting van die pole as rede aangevoer word waarom die dogter-chromosome na teenoorgestelde pole beweeg. Om die idee dat mitose presies in metodies-afgebakende stadia plaasvind uit te skakel, kan egter vooraf genoem word dat mitose 'n dinamiese, deurlopende proses is waar een stadium in 'n ander oorgaan sonder definitiewe afbakeningslyne.

W. GAUM en G. GERMISHUIZEN

GUIDE FOR AUTHORS

GENERAL

Bothalia is a medium for the publication of botanical papers dealing with the flora and vegetation of Southern Africa. Papers submitted for publication in Bothalia should conform to the general style and layout of recent issues of the journal (from Vol. 11 onwards) and may be written in either English or Afrikaans.

TEXT

Manuscripts should be typed, double-spaced on one side of uniformly-sized A4 paper having at least a margin of 3 cm all round. Latin names of plants should be underlined to indicate italics. All other marking of the copy should be left to the editor. Metric units are to be used throughout. Manuscripts should be submitted in duplicate to the Editor, Bothalia, Private Bag X101, Pretoria.

ABSTRACT

A short abstract of 100–200 words in both English and Afrikaans should be provided. In the abstract the names of new species and new combinations should not be underlined.

FIGURES

Black and white drawings, including graphs, should be in jet-black Indian ink preferably on bristol board or plastic film. Lines should be bold enough to stand reduction. Indicate the desired lettering lightly in pencil: the printer will insert the final lettering. If authors prefer to do their own lettering, then use some printing device such as stencilling, lettraset, etc. It is recommended that drawings should be twice the size of the final reduction.

Photographs submitted should be of good quality, glossy, sharp and of moderate, but not excessive contrast. Photograph mosaics should be composed by the authors themselves: the component photographs should be mounted neatly on a white card base leaving a narrow gap between each print; number the prints using some printing device.

Figures should be planned to fit, after reduction, into a width of 8 cm, 11 cm or 17 cm with a maximum vertical length of 24 cm.

The number of each figure and the author's name should be written on the back of the figure using a soft pencil.

Captions for figures should be collected together and typed on a separate page headed *Captions for Figures*. A copy of each caption should be attached to the base of each figure.

Authors should indicate in pencil in the text where they would like their illustrations to appear.

TABLES

Tables should be set out on separate sheets and numbered in Arabic numerals.

CITATION OF SPECIMENS

In citing specimens the grid reference system should be used (Technical Note: Gen. 4). Provinces/countries should be cited in the following order: S.W. Africa, Botswana, Transvaal, Orange Free State, Swaziland, Natal, Lesotho and the Cape. Grid references should be cited in numerical sequence. Locality records for specimens should preferably be given to within a quarter-degree square. Records from the same one-degree square are given in alphabetical order i.e. (–AC) precedes (–AD), etc. Records from the same quarter-degree square are arranged alphabetically according to the collectors' names; the quarter degree references must be repeated for each specimen cited. The following example will explain the procedure:

Natal.—2731 (Louwsburg): 16 km E. of Nongoma (–DD), *Pelser 354*; near Dwaarsrand, *Van der Merwe 4789*. 2829 (Harrismith): near Groothoek (–AB), *Smith 234*; Koffiefontein (–AB), *Taylor 720*; Cathedral-Peak Forest Station (–CC), *Marriott 74*; Wilgerfontein, *Roux 426*. Grid ref. unknown: Sterkstroom, *Strydom 12*.

Records from outside Southern Africa should be cited from north to south i.e. preceding those from Southern Africa. The abbreviation "distr." should be added to all district names e.g.:

Kenya.—Nairobi distr.: Nairobi plains beyond race course, *Napier 485*.

GIDS VIR SKRYWERS

ALGEMEEN

Bothalia is 'n medium vir die publikasie van plantkundige artikels wat handel oor die flora van Suidelike Afrika. Artikels wat voorgelê word vir publikasie in Bothalia behoort ooreen te stem met die algemene styl en rangskikking van onlangse uitgawes van die tydskrif (vanaf Vol. 11). Dit mag in Engels of in Afrikaans geskryf word.

TEKS

Manuskripte moet getik wees in dubbelspasiëring slegs op een kant van ewegroot A4-papier, met reg rondom 'n rand van minstens 3 cm breed. Latynse name van plante moet onderstreep word om aan te dui dat dit kursief gedruk moet word. Alle ander merke moet aan die redakteur oorgelaat word. Metrieke eenhede moet deurgaans gebruik word. Manuskripte moet in tweevoud ingedien word by die Redakteur, Bothalia, Privaatsak X101, Pretoria.

UITTREKSEL

'n Kort uittreksel van 100–200 woorde moet voorsien word, beide in Engels en Afrikaans. In die uittreksel moet die name van nuwe soorte en nuwe kombinasies nie onderstreep word nie.

AFBEELDINGS

Wit en swart tekeninge, insluitende grafieke, moet met pikswart Indiëse ink geteken word, verkieslik op "bristol board" of plastiekfilm. Lyne moet dik genoeg wees om verklein te kan word. Dui die verlangde byskrifte liggies in potlood aan: die drukker sal die uiteindelige byskrifte invoeg. Indien skrywers verkies om hulle eie byskrifte te maak, gebruik dan een of ander hulpmiddel soos lettraset of 'n sjabloon. Dit is wenslik dat tekeninge tweemaal so groot as die uiteindelige verkleining sal wees.

Foto's wat ingedien word, moet van hoë kwaliteit wees—glansend, skerp en van matige maar nie oordrewe kontras. Fotomosaieke moet deur die skrywer self saamgestel word: die afsonderlike foto's moet netjies monter word op 'n stuk wit karton met 'n smal strokie tussen die foto's; nommer die foto's met behulp van een of ander druk-hulpmiddel.

Afbeeldings moet so beplan word dat hulle na verkleining sal pas in 'n breedte van 8 cm, 11 cm of 17 cm met 'n maksimum vertikale lengte van 24 cm.

Die nommer van elke afbeelding sowel as die skrywer se naam moet op die rugkant van die afbeelding geskryf word met 'n sagte potlood.

Onderskrifte vir afbeeldings moet bymekaar getik word op 'n afsonderlike bladsy met die opskrif *Onderskrifte vir Afbeeldings*. 'n Afskrif van elke onderskrif moet aan die onderkant van elke afbeelding vasgeheg word.

Skrywers moet met potlood in die teks aandui waar hulle graag hulle afbeeldings wil hê.

TABELLE

Tabelle moet op afsonderlike velle papier kom en genummer word met Arabiese nommers.

SITERING VAN EKSEMPLEARE

Wanneer eksemplare siter word, moet die ruitverwysing stelsel gebruik word (Tegniese Nota: Gen. 4). Provinsies/lande moet in die volgende volgorde siter word: Suidwes-Afrika, Botswana, Transvaal, Oranje-Vrystaat, Swaziland, Natal, Lesotho en die Kaaprovinsie. Ruitverwysings moet in numeriese volgorde siter word. Lokaliteitsrekords vir eksemplare moet verkieslik tot binne kwartgraadvierkante gegee word. Rekords uit dieselfde eengraadvierkant word in alfabetiese volgorde aangebied, nl. (–AC) kom voor (–AD) ens. Rekords uit dieselfde kwartgraadvierkant word alfabeties gerangskik volgens die versamelers se name, en die kwartgraadverwysings moet herhaal word vir elke eksemplaar wat siter word. Die volgende voorbeeld sal die metode verduidelik:

Natal.—2731 (Louwsburg): 16 km O. van Nongoma (–DD), *Pelser 354*; naby Dwaarsrand, *Van der Merwe 4789*. 2829 (Harrismith): naby Groothoek (–AB), *Smith 234*; Koffiefontein (–AB), *Taylor 720*; Cathedral Peak Bosboustasie (–CC), *Marriott 74*; Wilgerfontein, *Roux 426*. Ruitverwysing onbekend: Sterkstroom, *Strydom 12*.

Rekords van buite Suidelike Afrika moet siter word van noord na suid, d.w.s. dit gaan dié van Suidelike Afrika vooraf. Die afkorting "distr." behoort by alle distriktsname gevoeg te word, bv:

Kenya.—Nairobi-distr.: Nairobi vlakte anderkant die renbaan, *Napier 485*.

REFERENCES

References in the test should be cited as follows: "Jones (1955) stated . . ." or ". . . (Smith, 1956)" when giving a reference simply as authority for a statement. The list of references at the end of the article should be arranged alphabetically and the literature abbreviations used should conform to the World List of Scientific Periodicals (1965) or the list of Literature Abbreviations (Technical Note: Tax. 6/3 AN 1) issued by the Botanical Research Institute, thus:

- BROWN, N. E., 1909. Asclepiadaceae. In W. T. Thiselton-Dyer, *Fl. Cap.* 6,2: 518-1036. London: Lovell Reeve.
- HUTCHINSON, J., 1946. *A botanist in Southern Africa*. London: Gawthorn.
- KRUGER, F. J., 1974. *The physiography and plant communities of the Jakkalsrivier Catchment*. M.Sc. (Forestry) thesis, University of Stellenbosch (unpublished).
- MORRIS, J. W., 1969. An ordination of the vegetation of Ntshongweni, Natal. *Bothalia* 10: 89-120.

If, as in many taxonomic papers, periodicals or books are mentioned in the text, usually in the species synopsis, they should be cited as in the following examples: Gilg & Ben. in Bot. Jb. 53: 240 (1915) and Burt Davy, Fl. Transv. 1: 122 (1926).

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VERWYSINGS

Verwysings in die teks moet as volg sêter word: "Jones (1955) beweer . . ." of ". . . (Smith, 1956)" wanneer 'n verwysing slegs as outoriteit vir 'n stelling gegee word. Die verwysingslys aan die einde van die artikel moet alfabeties gerangskik wees en die literatuurafkortings wat gebruik word, moet in ooreenstemming wees met die World List of Scientific Periodicals (1965) of die lys van Literatuurafkortings (Tegniese Nota: Tax. 6/3 AN 1) wat uitgegee is deur die Navorsingsinstituut vir Plantkunde, as volg:

- BROWN, N. E., 1909. Asclepiadaceae. In W. T. Thiselton-Dyer, *Fl. Cap.* 6,2: 518-1036. London: Lovell Reeve.
- HUTCHINSON, J., 1946. *A botanist in Southern Africa*. London: Gawthorn.
- KRUGER, F. J., 1974. *The physiography and plant communities of the Jakkalsrivier Catchment*. M.Sc. (Bosbou) tesis, Universiteit van Stellenbosch (ongepubliseerd).
- MORRIS, J. W., 1969. An ordination of the vegetation of Ntshongweni, Natal. *Bothalia* 10: 89-120.

Wanneer, soos in baie taksonomiese artikels die geval is, tydskrifte of boeke in die teks genoem word, gewoonlik in die soortsinopsis, behoort hulle sêter te word soos in die volgende voorbeelde: Gilg & Ben. in Bot. Jb. 53: 240 (1915) en Burt Davy, Fl. Transv. 1: 122 (1926).

HERDRUKKE

Skrywers ontvang 75 herdrukke gratis. Wanneer daar meer as een skrywer is, sal hierdie aantal tussen hulle verdeel moet word.

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Revision of *Melhania* in southern Africa

I. C. VERDOORN*

ABSTRACT

The 13 species of *Melhania* in southern Africa are revised. Among the problems resolved is a long-standing one concerning the identities of *M. rehmannii* Szyszl. and *M. griquensis* H. Bol., the latter in its strict sense being relegated to synonymy of the former.

RÉSUMÉ

REVISION DU MELHANIA EN AFRIQUE AUSTRALE

Les 13 espèces de *Melhania* d'Afrique australe sont révisées. Parmi les problèmes résolus il en est un qui fut de longue durée et qui concerne les identités du *M. rehmannii* Szyszl. et de *M. griquensis* H. Bol., ce dernier, dans le sens strict, étant relégué la synonymie du premier.

MELHANIA

Melhania Forssk., Fl. Aegypt.-Arab. 107: 64 (1775); Harv. in F. C. 1: 221 (1860); Arenes in Fl. de Madagascar 131, Sterculiaceae: 160 (1959); Wild in F. Z., 1, 2: (1961); M. Friedrich et al., F.S.W.A. 84: 23 (1969); R. A. Dyer, Gen. 1: 364 (1975).

Brotera Cav., Icon. 5: 19, t. 433 (1799).

Shrublets or herbaceous plants with a woody root-stock, the new growth usually pubescent; pubescence of stellate or tufted unicellular hairs often matted to form a thin or dense tomentum or in the case of long tufted hairs forming a hispid or villose pubescence, sometimes scales and short glandular hairs present as well. *Leaves* simple, petioled, stipulate. *Inflorescence* axillary, or terminal, racemose or cymose, often

reduced to a solitary flower; flowers bisexual, rarely polygamous. *Epicalyx-bracts* 3 persistent, united at the base, inserted subunilaterally, pubescent on both surfaces. *Calyx* 5-lobed, persistent. *Petals* yellow, 5, obovate, somewhat unequal-sided, convolute, hypogynous, early deciduous from the base but the faded flower persisting, like a cap, with convolute apices, on the capsule. *Stamens* 5, alternating with 5 ligulate staminodes, connate at the base forming a short annulus or collar. *Ovary* stellate-tomentose, 5-celled, ovules 1 to many in a cell; style with 5 stigmatic branches, sometimes abortive in essentially male flowers. *Capsule* loculicidally dehiscent. *Seeds* 3 or more sided usually with minute raised broken lines or dots on the surface.

The name *Melhania* is derived from Mt Melhan, in Arabia.

KEY TO SPECIES

- 1a Upper surface of leaves fairly sparsely pilose with rather long unicellular subappressed simple (or very rarely 2 to 3 together) hairs lying in the same direction:
 - 2a Leaves shallowly dentate, lateral veins excurrent in the teeth, lamina broad, mostly over 2,5 cm and up to 4 cm broad 1. *M. didyina*
 - 2b Leaves with entire margins very rarely a few teeth present on some leaves, upper surface early glabrescent, lamina mostly under 2,5 cm broad (see also under 1b) 2. *M. prostrata*
- 1b Upper surface of leaves glabrous (early glabrescent) or distinctly stellate pubescent or densely to sparsely stellate-tomentose:
 - 3a Leaves with entire margins, lamina mostly under 2,5 cm broad:
 - 4a Leaves velvety-tomentose on the upper surface, style long 6-8 mm long 3. *M. integra*
 - 4b Leaves early glabrescent on the upper surface, style short 2-3,5 mm long:
 - 5a Hairs when present on the upper surface simple subappressed lying in the same direction, veins impressed above 2. *M. prostrata*
 - 5b Hairs when present on the upper surface minutely stellate, net veins on glabrous leaves (Middelburg form) prominent above 4. *M. randii*
 - 3b Leaves serrate or crenate, obscurely so in *M. polygama*, but then lamina broad up to 5,5 cm broad:
 - 6a Epicalyx bracts broadly ovate to ovate-acuminate, rounded or cordate at the base (rarely sub lanceolate in *M. polygama*, which occurs only in N.E. Natal):
 - 7a Epicalyx as long as or longer than the calyx:
 - 8a Epicalyx broad, shortly and broadly acuminate, grey-tomentose; flowers bisexual; style short up to 3,5 mm long; plant ferruginous pubescent in part 5. *M. forbesii*
 - 8b Epicalyx long-acuminate, grey tomentose; flowers polygamous, the male with long styles \pm 7 mm long and abortive style-branches, female with short style, \pm 3 mm, and branches as long as or longer than the style; plant sulphur-grey tomentose 6. *M. polygama*
 - 7b Epicalyx shorter than the calyx: sometimes only slightly shorter in *M. transvaalensis*:
 - 9a Epicalyx abruptly acuminate; style long, up to 7 mm long; leaves tomentose on both surfaces 7. *M. acuminata* aggregate species
 - 10a Leaves usually broadly ovate-oblong, tomentum predominantly grey, interspersed with short light brown clustered hairs 7a. var. *acuminata*
 - 10b Leaves usually narrowly ovate-oblong, tomentum grey but copiously interspersed with rather long dark brown clustered hairs 7b. var. *agnosta*
 - 9b Epicalyx not or gradually acuminate in the upper half; style short:
 - 11a Leaves with the upper surface distinctly and coarsely stellate-pubescent throughout, not tomentose, usually more than twice as long as broad; flowers usually over 1 cm long, style short up to 5 mm long 8. *M. transvaalensis*

*c/o Botanical Research Institute, Department of Agriculture and Fisheries, Private Bag X101, Pretoria, 0001.

- 11b Leaves with upper surface stellate-tomentose to glabrescent usually less than twice as long as broad; flowers under 1 cm long. 9. *M. rehmannii*
- 6b Epicalyx-bracts linear-subulate to lanceolate; if fairly broad not broadest at the base:
- 12a Leaves not ovate, not broadest at or near the base; low plants under or up to 35 cm high with several to many stems arising from the base:
- 13a Epicalyx-bracts linear-subulate; flower-stalk short, \pm 4 mm long, shorter than the petiole and usually 1-flowered. 10. *M. virescens*
- 13b Epicalyx-bracts lanceolate, mature flower-stalk as long as or longer than the petiole, 10–40 mm long, 1–3-flowered. 11. *M. burchellii*
- 12b Leaves usually ovate to ovate-oblong, variable in shape but usually broadest at or near the base; shrublets usually over 30 cm tall, main stems 1 to a few, woody branched above:
- 14a Strong perennial, producing shoots from a reduced persistent woody base; leaves varying in size, 2–7 cm long, 1–4.5 cm broad. 12. *M. danarana*
- 14b Weak perennial, not producing roots from a woody base; leaves varying in size, but usually under 5 cm long, thin-textured and minutely tomentose on both surfaces, silvery grey on the under surface. 13. *M. suluensis*

1. *Melhania didyma* Eckl. & Zeyh., Enum. 52 (1834) Szyszyl. Polypet. Thalam. Rehm. 137 (1887) excl. var.; Harvey in F. C. 1: 222 (1860); K. Schum. in Engl., Monogr. Afr. Pfl. 5: 10 (1900) excl. var. Syntypes: Uitenhage, Winterhoek Mountains, *Ecklon & Zeyher* s.n. (SAM!); Zuurbergen, *Ecklon & Zeyher* s.n.

Vitalia macrophylla Vis., Ind. Sem. Patav. in Linnaea 15, Litt. 103 (1840) Described from plant grown from seed, origin unknown.

Melhania leucantha E. Mey. in Drège, Zwei Pfl. Doc. 201, 133 & 134 (1843) nom. nud.

Shrublet, 20–60 cm tall, sometimes up to 1 m tall, branched from near the base, erect or, when browsed, forming a low bushy plant, main stem woody; branchlets tomentose, the grey tomentum intermixed with light brown, clustered, villous hairs. *Stipules* subulate, tomentose, up to 14 cm long. *Leaves* pubescent above with subappressed, long, single hairs or very occasionally 2 or 3 hairs from the same base, greyish-stellate-tomentose beneath intermixed with clustered light brown hairs, especially on the nerves, ovate-oblong to ovate-lanceolate, up to 10 cm long and 4 cm broad, margins shallowly dentate, sometimes obscurely so; petiole 0.7–1.5 cm long. *Inflorescence* axillary, peduncle rigid, up to 5 cm long, usually 2-flowered at the apex, pedicels up to 1 cm long. *Epicalyx-bracts*, broadly ovate, acuminate, cuspidate at the apex, cordate at the base, usually slightly longer than the calyx and petals,

densely tomentose to villous-tomentose on both sides, up to 2.5 cm long, 1.3 cm broad, usually longer than the calyx. *Calyx* lobed almost to the base, lobes ovate-lanceolate, up to 1.5 cm long, hirsute-hispid without. *Petals* about as long as the calyx, broadest at the apex, pale yellow, fading brownish yellow. *Stamens* 5, alternating with 5 linear-ligulate staminodes which are about twice as long as the stamens. *Ovary* subglobose densely villous; style about 3–5 mm long, branches 1.75–2 mm long; ovules 4–5 in a cell. *Capsule* hispid with tufted hairs. Fig. 1.

Occurs on grassy slopes, thorn veld or margins of open forests, often near rivers. Recorded from the eastern Cape, Swaziland, Natal and the eastern Transvaal.

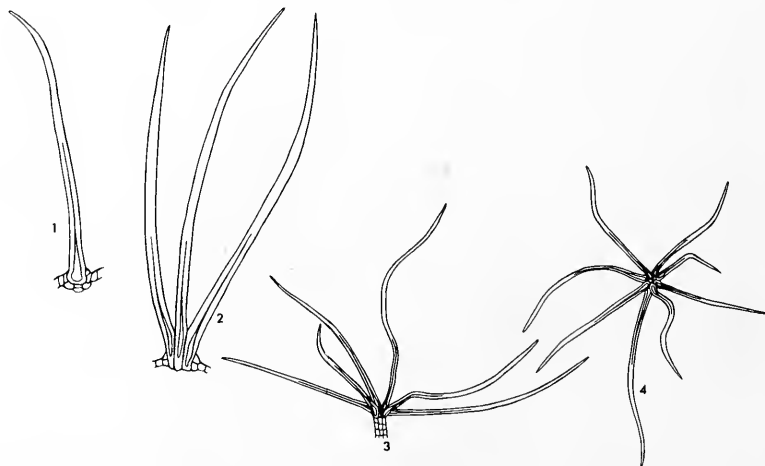
TRANSVAAL*.—Nelspruit: Kaapsche Hoop, Rogers 20875.

SWAZILAND.—Mbabane: Hlane Wildlife Sanctuary, Stephen 1451.

NATAL.—Alfred: Izingolweni, Strey 6146. Durban: Krauss 217. Eshowe: near Dhlangubo store, Codd & Verdoorn 10175. Estcourt: Jones's Kloof, West 1548. Hlabisa: Hluhluwe, Wells 2120. Lower Umfolozi: Umfolozi Game Reserve, Strey 4958. Mapumula: 16 km NE of Thring's Post, Codd & Verdoorn 10180. Port Shepstone: Umzimkulu 'horseshoe' slopes, Strey 7459. Umzinto: Imhambanyoni Valley, King 114.

CAPE.—Albany: Kudu Nature Reserve, Fort Brown, Gibbs Russell 3652. Alice: Woburn, Acocks 9823. East London: Nahoon River Valley, Smith 3753. Fort Beaufort: Fort Fordyce, Story 2114. Kokstad: Umzimvubu Cutting, Strey 10707. Komga: Flanagan 9. Mqunduli: Pegler 578. Queenstown: Junction Farm, Galpin 8078. Uitenhage: Groendal, Long 1162.

FIG. 1.—*Melhania didyma*. Differences between hairs on upper and lower surfaces of leaves. 1 & 2, simple and tufted hairs from upper surface; 3 & 4, stellate hairs with slender rays, side and dorsal views, from lower surface. All \times 50.



* The specimen citations in this and the following two papers are arranged alphabetically according to districts.

According to Harvey in F. C. 1: 222, *M. leucantha* E. Mey. nom. nud. is this species. The Drège specimens at Kew which Meyer named *M. leucantha* have been examined and they are *M. didyma*.

M. didyma resembles *M. forbesii* in some respects and especially in the size and shape of the epicalyx-bracts, but it is readily distinguished by the upper surface of the leaf being pubescent with single subappressed hairs, while in *M. forbesii* it is tomentose or with short, grouped or stellate hairs.

The specimens from Botswana listed by O. B. Miller in J1 S. Afr. Bot. 18: 57 (1952) as *M. didyma* are *M. forbesii* and most probably *Dinter* 3036 from Tsumeb, listed as *M. didyma* in Feddes Reprium 19: 96 (1924) is, judging by the locality, also this species.

For the relationship between *M. didyma* and *M. prostrata* see the notes under the latter species.

2. *Melania prostrata* DC., Prodr. 1: 499 (Jan. 1824); Burch., Trav. 2: 263 (1824); Harv. in F. C. 1: 222 (1860); K. Schum. in Engl., Monogr. Afr. Pfl. 5: 9 (1900); Burt Davy, Fl. Transv. 1: 260 (1926); Wild in F. Z. 1, 2: 530 (1961). Type: Cape, Kimberley, Klipfontein, Burchell 2153 (PRE, iso.!).

M. linearifolia Sond. in Linnaea 23: 18 (1850); Harv. in F. C. 1: 222 (1860). Type: Natal, Durban Gueinzus 532 (S, holo.!, PRE photo.!).

M. didyma var. *linearifolia* (Sond.) Szyszyl., Polypet. Thalam. Rehm. 137 (1887); K. Schum. in Engl., Monogr. Afr. Pfl. 5: 10 (1900); Burt Davy, Fl. Transv. 1: 261 (1926).

M. prostrata forma *latifolia* Bak. f. in J. Bot., Lond. 37: 425 (1899). Type: Zimbabwe, Bulawayo, Rand 24.

Shrublet, a weak to fairly strong perennial, usually branching near the base; branches upright, spreading or prostrate, usually branched again 20–60 cm long, new growth grey-stellate-tomentose, tomentum interspersed in parts with scattered red-brown, bunched hairs. *Stipules* subulate 4–14 mm long. *Leaves* linear-lanceolate linear-oblong, narrowly oblong or narrowly ovate-oblong, rounded at base and apex, rarely apex truncate and very shallowly lobed, 2.4–12 cm long, 0.4–2 cm broad, rarely 2.5 cm broad, discoloured, lower surface grey-tomentose with golden-brown, lepidote, stellate-pilose scales bearing short or long hairs upper surface fairly sparsely pubescent with mostly rather long single, (or rarely about 3 in a cluster), subappressed hairs, lying ± in the same direction or glabrous; margins entire, very rarely shallowly lobed in part; lateral veins few, impressed above, prominent beneath, not excurrent; petiole 0.2–1.2 cm long, rarely 1.5 cm long, grey tomentose. *Inflorescence* axillary 1–2-flowered; peduncles 3–32 mm long, ultimately longer than the petioles which range from 2–12 mm, frequently in the single flowered inflorescence the peduncle and pedicels are indistinguishable. *Epicalyx-bracts* from narrowly to broadly ovate-acuminate, shallowly to deeply cordate at the base and abruptly narrowed in a short basal claw, about 8–15 mm long and 2–6.5 mm broad, thinly to densely stellate-tomentose on both surfaces. *Calyx* with lobes ovate-lanceolate, acuminate, shorter or longer than the epicalyx, 8–14 mm long, 2.5–4 mm broad, dorsally grey-tomentose, sparsely to very densely interspersed with bunched or stellate golden-brown, bristle-like hairs. *Petals* yellow, broadest at the apex cuneate, about 12 mm long and 8 mm broad at apex. *Stamens* about 4 mm long, alternating with linear-ligulate staminodes somewhat longer than the stamens. *Ovary* subglobose densely tomentose and bristly with bunched or

stellate hairs; style 1.5–3.75 mm long with branches half to three quarters as long; ovules 6–8 in a cell. Fig. 2.



FIG. 2.—*Melania prostrata*. Burchell 2153, isotype in PRE.

Found on rocky slopes, sand flats, grasslands and bushveld from Griqualand West, northern Cape, throughout the Transvaal into Botswana, Swaziland and Zululand. Also recorded from Zimbabwe and Mozambique.

BOTSWANA.—South East District: Dikomo di Ki, Wild 5179.

TRANSVAAL.—Barberton, Pott 5634. Brits: Jacksonstun, Van Vuuren 418. Heidelberg: Suikerbosrand Nature Reserve, Lambrechts 183. Johannesburg: Schoongezicht, Mogg 22932. Letaba: Hans Merensky Nature Reserve, Oates 391. Lydenburg: Kruger's Post, Burt Davy 7303. Marico: 4.8 km S. W. Zeerust, Strey 795. Middelburg: Loskop Dam, Codd & Verdoorn 10366. Nelspruit: Lowveld Botanic Gardens, Buitendag 775. Pietersburg: Chuniespoort, Codd & Verdoorn, 10478. Pilgrims Rest: Erasmus Pass, Killick & Strey 2522. Potchefstroom: Venterskroon, Van Wyk 1428. Potgietersrust: Pyramid Estate, Galpin 8923. Pretoria: Wonderboom, Thode A 396. Rustenburg: Rustenburg Nature Reserve, Jacobsen 1146. Soutpansberg: 37 km N. of Louis Trichardt, Magill 9630A. Vereeniging: Suikerbosrand, Bredenkamp 532. Waterberg: Kransberg, Germishuizen 280.

O.F.S.—Senekal: Doringberg-oos, Muller 1866.

SWAZILAND.—Stegi: Blue Jay Ranch, Compton 29746.

NATAL.—Hlabisa: Hluhluwe Game Reserve, Ward 1772. Ingwuvuma: Josini Dam, Strey 5283. Ngotshe: Makatini flats, Wells 2219. Ubombo: Lebombo Mts, near Ubombo, Acocks 13124.

CAPE.—Barkly West: Klipplei, Esterhuysen 2082. Hay: Berge-naars Pad, Acocks 2087. Kuruman: 17.2 km N. W. of Kuruman, Leistner 596. Philipstown: near Petrusville, Jooste 285.

The decision to follow the authors of *Flora Zambesiaca* and put *M. linearifolia* Sond. into synonymy under *M. prostrata* and not as a variety of *M. didyma* as Szyszylowicz did, was made after seeing the type specimen of the former, *Gueinzus* 532. This specimen compares well with the type of *M. prostrata* from Griqualand West and the many specimens of this species found throughout the Transvaal and in parts of Natal.

M. prostrata is closely related to *M. didyma*, but may be distinguished by the much narrower leaves with entire margins (very rarely a single leaf shallowly lobed in part). The pubescence on the upper surface of the leaves is, when present, like that of *M. didyma* of rather long usual single subappressed hairs, but in *M. prostrata* the upper surface is early glabrescent.

Where the distribution of these two species overlap, intermediates are found. It is not clear whether these intermediates are of hybrid origin or whether the two taxa are fairly recent segregates from a common stock.

The specimen of *Schlechter* 4322 in the Transvaal Museum Herbarium, now in the National Herbarium, is a mixture of *M. prostrata* and *M. transvaalensis*. The latter has the upper surface of the leaves distinctly stellate throughout.

When Burchell collected the type of this species, *Burchell* 2153, he evidently thought it was a *Dombeya*, for in his catalogue he has listed it as *Dombeya prostrata*.

3. *Melhania integra* Verdoorn in *Bothalia* 8: 177 (1964). Type: Transvaal, Pietersburg, Wolkberg, Codd & Verdoorn 10407. (PRE, holo.!).

Shrublet, 20–45 cm tall with several slender woody stems from a woody rootstock, laxly branched; branches shortly and densely tomentose, sometimes, in new growth reddish-brown lepidote stellate scales are obvious. *Stipules* subulate, 6–15 mm long. *Leaves* on flowering branches clustered towards the apex, entire (very rarely lower leaves shallowly toothed in part), finely and densely velvety tomentose on the upper surface, greyish tomentose beneath with reddish, lepidote, stellate scales usually obvious, especially on the nerves, narrowly lanceolate-elliptic, mostly 2–6.5 cm long and 0.4–1.2 cm broad, sometimes up to 1.8 cm broad, nerves prominent beneath, obscure above, basal nerves 3, rarely 5, base subrounded, apex subacute or rounded, mucronate; petiole 0.4–1 cm long, tomentose with a few to many reddish-brown, lepidote stellate scales obvious. *Inflorescence* axillary in the upper leaves, 1–3-flowered; peduncle 4–20 mm long, pedicels 3–14 mm long, both tomentose with scattered reddish-brown stellate scales obvious in parts. *Epicalyx-bracts* ovate acuminate, rounded to cordate at the base, about 12 mm long, 6 mm broad near the base, tomentose on both surfaces with the lepidote scales obvious on the outside. *Calyx-lobes* lanceolate, acuminate, about 15 mm long, 3.5 mm broad near the base, tomentose and lepidote without. *Petals* canary yellow, turning brownish at maturity, broadest at the apex, about 16 mm long, 10–14 mm broad at apex. *Stamens* with filaments 1 mm long, anthers 3–4 mm long, staminodes 9 mm long. *Ovary* subglobose, about 3 mm diam., white tomentose; style about 6–8 mm long, branches 1.5–3 mm long; ovules 7 in each locule. *Capsule* about 10 mm long, 8 mm diam., shortly tomentose and scaly, the scales bearing short hairs. Fig. 3.

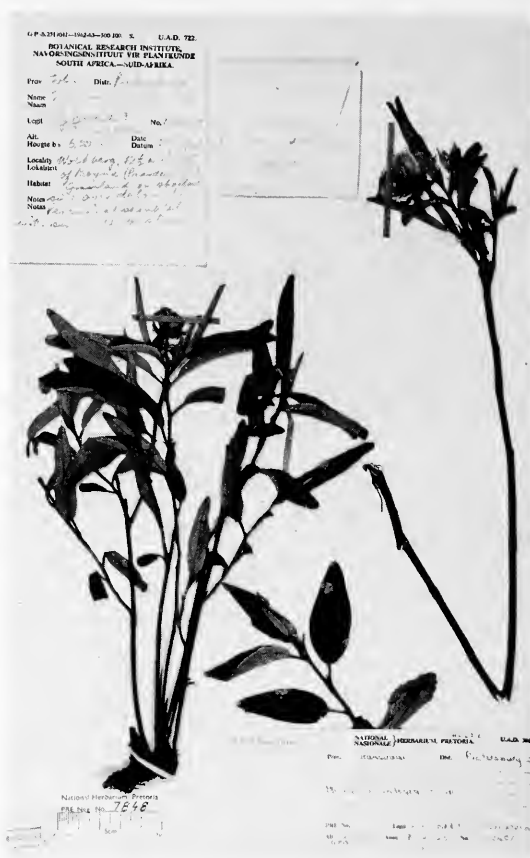


FIG. 3.—*Melhania integra*. Codd & Verdoorn 10407, isotype in PRE.

Recorded from the Wolkberg, the northern extremity of the Transvaal Drakensberg and at the top of Abel Erasmus Pass, growing on rocky hillsides among grass in shallow soil over dolomite.

TRANSVAAL.—Letaba: Dalton Farm, above Dublin Mine, *Fourie* 601; Pietersburg: Wolkberg, Paardevlei, Codd & Verdoorn 10407; Verdoorn 2474; Pilgrims Rest: Abel Erasmus Pass, *Mauve* 4790.

This species occurs abundantly in the area which lies south-east of Boyne in the Pietersburg District and on the borders of the Letaba District. It grows on the grassy slopes among dolomite rocks. The entire, velvety-tomentose leaves, together with the long style and large petals, characterize the species.

It resembles *M. randii* Bak. f. from Zimbabwe in the entire leaves but differs, among other things, in the pubescence on the upper surface of the leaves, the larger flowers and the ovate-cordate epicalyx. The specimen from Abel Erasmus Pass is not quite as velvety as the Wolkberg specimens.

4. *Melhania randii* Bak. f. in *J. Bot., Lond.* 37: 425 (1899); K. Schum. in Engl., *Monogr. Afr. Pfl.* 5: 6 (1900); Wild in *F. Z.* 1, 2: 530 (1961). Type: Zimbabwe, Salisbury, *Rand* 439 (BM, holo.).

Shrublet, 6–60 cm tall with several slender woody stems from a thick, woody rootstock, branches at first finely stellate-tomentose with minute reddish brown scales intermingled. *Stipules* narrowly lanceolate-subulate up to 8 mm long. *Leaves* entire, rarely some shallowly dentate in part, finely minutely

stellate-tomentose and with scattered reddish brown scales (the scales sometimes stalked and all bearing short hairs) on the under surface, the upper surface finely stellate-tomentose and in some forms early glabrescent, narrowly oblong-elliptic or lanceolate-elliptic to ovate-oblong, 2–9 cm long, 0.2–1.5 cm broad, rounded at the base, subacute to rounded at the apex, mucronate; petiole up to 1 cm long, tomentose and lepidote. *Inflorescence* axillary, tomentose and lepidote, 1–3-flowered; peduncle 7 mm long and indistinguishable from the pedicel or up to 4 cm long and pedicels up to 1.2 cm long. *Epicalyx-bracts* narrowly lanceolate, narrowly ovate to ovate-acuminate, from 6–13 mm long and 1–6 mm broad (large bracts found mostly on the specimens from the eastern mountainous country), tomentose on both surfaces and with minute reddish scales intermixed on upper surface. *Calyx-lobes* lanceolate-acuminate, up to 11 mm long, tomentose and with conspicuous reddish brown scales on outer surface. *Petals* yellow, 'bright golden yellow' about 9 mm long, 7 mm broad at the oblique apex. *Stamens* with filaments 1 mm long, anthers 2–3 mm long, staminodes 3–5 mm long. *Ovary* stellate tomentose and with straight bristly hairs especially in upper portion, about 2 mm diam., style short, at maturity up to 2 mm long, branches when spreading up to 3 mm long. *Capsule* up to 1 cm long, stellate-pubescent and scaly.

Recorded from the Middelburg District, where it grows in open mixed grassveld in iron-rich soil and a taller form from the Barberton District on the exposed, wind-swept summit of a mountain near Barberton. Also occurs in Zimbabwe and Mozambique.

TRANSVAAL.—Barberton: Sheba Hills, Russel's Beacon, Scheepers 1247; Verdoorn 2479. Middelburg: Roos Senekal, Verdoorn 2492; 2501; 2502; 2503; 2504.

M. randii has been recorded from four widely separated areas of distribution. Probably the long period of isolation accounts for the plants in any one of these colonies differing in some respects from those in another. The specimens seen to date from around Salisbury, the type locality, are low bushes with long narrow leaves on which the pubescence persists on the upper surface. In the mountainous eastern regions of Zimbabwe and the Transvaal the plants are over 30 cm tall with slender erect stems; they also have long leaves with persistent pubescence on the upper surface, and differ only slightly from each other, for instance the epicalyx bracts on the Transvaal specimens are usually broader than those on the Zimbabwean specimens. The form found in the Middelburg District of the Transvaal differs from all the others in having shorter and broader leaves, which are early glabrescent on the upper surface. In this form the bushes are usually under 30 cm tall.

M. randii resembles *M. prostrata* and *M. integra* in the entire leaves. It can be distinguished from the former, among other things, by the upper surface of the leaves being finely stellate-pubescent before becoming glabrous as opposed to having long simple, appressed hairs on the upper surface, before becoming glabrous. From *M. integra* it may be distinguished by the persistent minutely stellate pubescence of the upper surface of the leaf as well as the short style and smaller flowers, the styles being 1.75 mm long as opposed to 8 mm long in *M. integra* and the flowers 1.1 cm long as opposed to being 2 cm long.

5. *Melhanie forbesii* Planch. ex Mast. in F.T.A. 1: 231 (1868); K. Schum. in Engl., Monogr. Aft. Pfl. 5: 12 (1900); Burtt Davy, Fl. Transv. 1: 261 (1926); Wild in F.Z. 1, 2: 531 (1961); M. Friedrich et al.,

F.S.W.A. 84: 25 (1969). Syntypes: Mozambique, Cupanga, Kirk (K); without precise locality, Hutton (K).

M. serrulata R. E. Fr., Wiss. Ergebn. Schwed. Rhod.-Kongo-Exped. 1: 157 (1914). Type: Zimbabwe, Victoria Falls, Fries 74 (UPS).

Shrublet about 60 cm tall, sometimes taller, stem erect, branched; branches suberect the upper portion usually appearing rust-coloured from the clusters of rather long ferruginous hairs, which are sometimes stalked and occur more or less densely intermingled with the short greyish stellate tomentum. *Stipules* subulate 10–20 mm long. *Leaves* greyish tomentose with short, fine grouped or stellate hairs especially dense on the lower surface, and sometimes with clusters of ferruginous hairs on the nerves beneath, more or less ovate-oblong, 3–11 cm long, 1, 5–6 cm broad, rounded at the apex, sometimes mucronate, base rounded to cordate, margin crenate-serrulate; petiole 1–2.5 cm long, usually densely covered with clusters of ferruginous hairs. *Inflorescence* axillary, peduncles straight, tomentose and with numerous clusters of ferruginous hairs, suberect, 1–6 cm long, branched near the apex; raceme 1–4-flowered, usually 3-flowered; pedicels 2–7 mm long. *Epicalyx-bracts* from about 12–18 mm long and 10–14 mm broad, ovate, sometimes broadly acuminate to an acute apex (not abruptly so), cordate at the base, longer than the calyx and petals (in dried specimens obscuring the calyx), tomentose on both surfaces. *Calyx-lobes* greyish villose-tomentose dorsally, glabrous within, lanceolate about 1 cm long, apex acute. *Petals* about as long as the calyx-lobes, obovate, broadest at the apex (the faded petals twisted at the apex and persisting like a cap on the capsule may appear to be longer than the calyx but they are not attached at the base). *Stamens* about 12 mm long, filaments and anthers about 5 mm long. *Ovary* subglobose about 9 mm diam., densely tomentose; style about 2 mm long, style-branches about 4 mm long. *Seeds* up to 6 in a cell.

Found along rivers in alluvial soil or on dolomitic hillsides, sandy flats and parkland in red soil. Recorded from Natal, Swaziland, the eastern and northern Transvaal; and northern South West Africa. Also occurs in Mozambique, Zambia, Zimbabwe and Angola.

S.W.A.—Eastern Caprivi: Linyanti area, Killick & Leistner 3169, Grootfontein: foot of Aha Mtns, Story 6376. Okavango: Nianzana, Dinter 7252. Ovambo: Oshihanga, Loeb 563.

BOTSWANA.—Central District: Orapa, Allen 126. Ngamiland: Plains near Tsodilo Hills, Banks 59.

TRANSVAAL.—Barberton: Komatipoort, Marloth 5457. Letaba: Hans Merensky Nature Reserve, Gilliland 782. Nelspruit: E. of Skukuza, Codd & de Winter 5015. Pietersburg: Chuniespoort, Codd & Verdoorn 10460. Pilgrims Rest: Dindinnie Farm, Mauve 4793. Soutpansberg: Punda Milia, Schlieben 9334. Waterberg: Krantzberg area, Germishuizen 267.

SWAZILAND.—Hlatikulu: near Sipofaneni, Compton 29891. Tabankula: Barrett 312. Tshanani: Swaziland Irrigation Scheme, Riches 12.

NATAL.—Hlabisa: False Bay Park, Scott-Smith & Ward 70. Ingwavuma: Kosi Estuary, Vahrmeijer & Tölken 914. Ubombo: Mkuzi Game Reserve, Ward 4123.

In the shape of the epicalyx *M. forbesii* closely resembles *M. didyma*, but can be readily distinguished by the upper surface of the leaves being tomentose and minutely stellate and not pubescent with single, long, sub-appressed hairs as in *M. didyma*. The specimens from Botswana listed by O. B. Miller in Jl S. Afr. Bot. 18: 57 (1952) as *M. didyma* are *M. forbesii* and, most probably, Dinter 3036 also listed

as *M. didyma* from Tsumeb, in Feddes Reprim 19: 96 (1924), is this species. (See also notes under *M. acuminata* var. *acuminata*.)

The native name for *M. forbesii* is moulhwadambo meaning 'setting sun'.

6. *Melhania polygama* Verdoorn in Bothalia 8: 178 (1964) Type: Natal, Umfolozi Game Reserve, Strey 4957b (PRE, holo.!).

Shrublet about 35 cm tall, with a woody rootstock. *Stems* many, rather robust, in dried specimens 3–5 mm diam., laxly branched, new growth with a sulphur-grey stellate tomentum, the hairs of different lengths and grouped on scales. *Stipules* subulate, 5–10 mm long. *Leaves* finely and densely sulphur-grey stellate-tomentose on both surfaces, upper surface somewhat darker than the lower; lamina broadly ovate-trullate or ovate-elliptic, 3–9, 5 cm long, 1.5–5.5 cm broad, broadly cuneate or subrounded at the base, narrowing slightly to the obtuse or subtruncate apex, shallowly crenate-dentate except at the base; petiole 1–2 cm long, densely sulphur-grey tomentose, fairly stout. *Inflorescence* in axils of upper leaves; peduncle up to 6 cm long, stellate-tomentose, 1–3-flowered at apex; pedicels 0.3–1.5 cm long. *Flowers* polygamous. *Epicalyx-bracts* ovate, cordate at base, gradually attenuating to a subulate upper portion and acute apex, longer than calyx, about 14 mm long, 4–12 mm wide, stellate-tomentose on both surfaces. *Calyx* with lobes deltoid-acuminate, about 11 mm long, outer surface stellate-tomentose. *Petals* yellow, broadest at the apex, in essentially male flowers about 14 mm long, in female shorter, about 10 mm long. *Stamens*, in male flowers, with anthers about 4 mm long, in female abortive, about 2 mm long; ligulate staminodes about 6.5 mm long. *Ovary* densely beset with long, grouped hairs on scales; style in male flowers long and slender, about 7 mm long, branches aborted or short, style in female flowers thick and short, about 2.5 mm long, branches longer than the style, about 5 mm long, sometimes decurrent on the style; ovules 5 in a cell. *Capsule* broadly oblong, about 9 mm long, tomentose and with groups of rather long, sulphur-coloured hairs. Fig. 4.

To date recorded only from the Umfolozi Game Reserve, Zululand, where it grows on grassy hill-slopes.

NATAL.—Lower Umfolozi: Umfolozi Game Reserve, Ward 3324; Dengesen Beacon Hill, Strey 4957a; 4957b; 4957c; 4957d.

This is the first known record of a species of *Melhania* with polygamous flowers. The essentially male flowers are more showy with longer petals, large stamens and an aborted style. The female flowers have short petals, small stamens and a style with long, stout branches. The broad ovate-trullate leaves, that is, leaves, which are usually broadest about a third of length above the base, are a distinguishing feature.

7. *Melhania acuminata* Mast. in F.T.A. 1: 231 (1868); Wild in F.Z. 1, 2: 532 (1961). Type: Mozambique, Sena, Kirk s.n. (K, holo.).

Shrublet about 65 cm tall; stem erect from a comparatively slender tap-root, branched; branches erect and spreading, new growth greyish stellate-tomentose and sometimes with bunched light to dark brown hairs intermixed. *Stipules* subulate, 0.5–1.7 cm long. *Leaves* greyish stellate-tomentose on both surfaces, sometimes more thinly so on the upper surface, lower



FIG. 4.—*Melhania polygama*. Strey 4957, holotype in PRE.

surface sometimes with light to dark brown bunched hairs, especially on the prominent nerves, broadly to narrowly ovate-oblong, 3.5–10 cm long, 1.5–6 cm broad, narrowing towards a broadly rounded apex, rounded to subcordate at the base, margins crenate-serrate; petiole 1–2.5 cm long, stellate-tomentose. *Inflorescence* axillary, peduncle straight, suberect up to 5 cm long, 3- or more-flowered near the apex; pedicels 0.6–1 cm long. *Epicalyx-bracts* ovate (rarely narrowly so), shorter than the calyx, rounded at the base and with a very short broad claw, abruptly acuminate above into a caudate-like upper half, tomentose on both surfaces. *Calyx* with lobes lanceolate, gradually narrowing to the acute apex, 1–1.5 cm long, stellate-tomentose on the outside only. *Petals* usually longer than the epicalyx, obovate, broadest at apex. 1–1.5 cm long. *Stamens* with filaments and anthers about 3.5 mm long; staminodes 7 mm long. *Ovary* subglobose about 8 mm diam., densely tomentose; style 6–10 mm long, branches 1–2 mm long; ovules 6 in a cell.

For key to varieties see key to species.

(a) var. *acuminata*. Wild in F.Z. 1, 2: 532 (1961).

M. acuminata Mast. in F.T.A. 1: 231 (1868); K. Schum. in Engl., Monogr. Afr. Pfl. 5: 13 (1900); Burtt Davy, Fl. Transv. 1: 261 (1926); M. Friedrich et al., F.S.W.A. 84: 24 (1969); *M. velutina* sensu Excell & Mendonça, C.F.A. 1, 2: 190 (1951), pro parte.

The typical variety is characterized by the leaves usually being broadly ovate to ovate-oblong, the flower large, and the rather thick tomentum being predominantly grey with fairly obscure, bunched,

brown hairs intermixed. There is a fair number of herbarium specimens, which approach var. *agnosta* either in the leaves being narrower than usual or the bunched hairs somewhat more conspicuous. This supports the decision to reduce *M. agnosta* K. Schum. to varietal rank under *M. acuminata*.

Found in sandy soil, on flats, in bushveld and on grassy wooded slopes. Recorded from the northern Cape, the northern and eastern Transvaal, South West Africa and Botswana. Also occurs in Zambia, Zimbabwe, Angola and Mozambique.

S.W.A.—Gobabis: Farm Davis, *Merxmüller* 1206. Grootfontein: Neitsas, *Schonfelder* 1051. Kavango: E. of Runtu, *De Winter* 3788. Otjiwarongo: Quickborn, *Bradfield* 366. Outjo: Chorab, *Dinter* 5352. Owambo: S.E. of Oshikango, *Rodin* 9118. Tsumeb: Farm Kumhuase, *Gies* 14975.

BOTSWANA.—Central Dist.: Seleka Ranch, *Hansen* 3070. Chobe: on track to Sajawa, *Smith* 2627. Glanzi N.W. of Malepolole, *Story* 4973. Kgalagadi: Kang, *Mott* 291. Kweneng: between Gaberones and Thamaga, *Reyneke* 329. Ngamiland: Okavango Delta, *Smith* 387.

TRANSVAAL.—Groblersdal: Loskop Dam to The Hell, *Codd & Verdoorn* 10366b. Letaba: K.N.P. *Van der Schijff* 2779. Lydenburg: N.E. of Penge Mine, *Leistner* 3465. Nelspruit: Malelane Camp, *Acoc* 16726. Pilgrims Rest: Olifants River bank, *Pole Evans* H. 17021. Potgietersrus: on Limpopo River bank near Usutu, *Van Graan & Hardy* 451. Waterberg: N.E. of Nylstroom, *Codd & Verdoorn* 10435. Soutpansberg: E. of Wylies Poort, *Meuse* 9207.

CAPE.—Vryburg: near Malope River, *Mostert* 1244.

M. acuminata var. *acuminata* is sometimes confused with *M. forbesii*, which has more or less the same habit and partly the same distribution. These taxa are mainly distinguished by the shape and length of the epicalyx-bracts around the length of the style.

According to Wild in F.Z., 1, 2: 532 (1961), *M. velutina* sensu Exell & Mendonça in Conspectus Florae Angolensis 1, 2: 190 (1951) is partly *M. acuminata*.

A note on *Rodin* 9291 from Kwanzama, South West Africa, reads, 'leaves are stamped and sap is put on wounds to heal them'.

(b) var. *agnosta* (K. Schum.) Wild in Bolm Soc. broteriana ser. 2, 33: 36 (1959). Type: Transvaal, Makapaansberg, Strydpoort, *Rehmann* 5490 (K, iso!; PRE, photo!). Fig. 5.

M. agnosta K. Schum. in Engl., Monogr. Afr. Pfl. 5: 11 (1900); Burt Davy, Fl. Transv. 1: 261 (1926). Type as above.

M. ferruginea sensu Szyszyl., Polypet. Disc. Rehmann 139 (1887), pro parte as to *Rehmann* 5490.

M. obtusa N.E. Br. in Kew Bull. 1906: 99 (1906). Type: Zimbabwe, near Bulawayo, *Cecil* 94 (K, holo.).

This variety differs from the typical in the leaves being narrowly oblong or narrowly ovate-oblong and the tomentum on the new growth being densely interspersed with bunched, dark-brown hairs. The flowers are smaller on the whole and usually clustered at the apices of the branchlets. It agrees with the typical in the characteristic abruptly-acuminate epicalyx-bracts, the long style, general habit and the long peduncles bearing 1 to 4 flowers at the apex.

Recorded from Botswana and the Transvaal. Also occurs in Zambia, Zimbabwe and Mozambique.

BOTSWANA.—Kanye: near Pharing, O. B. Miller B/586.

TRANSVAAL.—Pietersburg: Strydpoort, Makapaansberg, *Rehmann* 5490.

A specimen collected in 1978 on the Pilanesberg, Rustenburg District, *Peeters, Gericke & Burelli* 590 may be this variety although the leaves are somewhat broader than in the type specimen.



FIG. 5.—*Melhania acuminata* var. *agnosta*. *Rehmann* 5490, iso-type in K.

8. *Melhania transvaalensis* Szyszyl., Polypet. Thalam. Rehmann 138 (1887); K. Schum. in Engl., Monogr. Afr. Pfl. 5: 11 (1900); Burt Davy, Fl. Transv. 1: 261 (1926). Type: Transvaal, Elandsriver drift, *Rehmann* 4940.

Shrublet 14–60 cm tall, stems many arising annually from the base, laxly branched, new growth grey or off-white tomentose, tomentum interspersed with bunched hairs which are sometimes yellowish-brown. *Stipules* subulate, tomentose, 4–14 mm long. *Leaves* oblong, narrowly oblong or ovate-oblong, usually more than twice as long as broad, 2–9 cm long 0.7–3 cm broad, rounded to subtruncate at the apex, more or less rounded at the base, margins fairly distantly crenate dentate, upper surface with distinct coarse stellate pubescence only (not tomentose with fine bunched or stellate hairs), under surface white to grey stellate-tomentose; petiole stellate-tomentose, from about 5–20 mm long. *Inflorescence* axillary in upper leaves usually 1-flowered, stalk 1–2.5 cm long, often with an articulation somewhere about midway distinguishing the pedicel from the peduncle. *Epicalyx-bracts* ovate-lanceolate, long acuminate, subcordate at the base, 10–12 mm long, about 3.5 mm broad, stellate-tomentose on both surfaces. *Calyx* with lobes lanceolate, slightly longer and narrower than the epicalyx-bracts, 12–14 mm long, 3 mm broad, long acuminate, stellate-tomentose, with clustered yellow-brown hairs interspersed on the outer surface, subglabrous on inner. *Petals* yellow, about 13 mm long. *Stamens* slightly shorter than the ligulate 8 mm long staminodes. *Ovary* more or less ovoid, stellate-tomentose; style 2.5–3.5 mm long, branches 2.5 mm long. *Capsule* ovoid, about 12 × 8 mm, with off-white tomentum mixed with rather long grouped, yellowish hairs.

Found on stony hills and grassy slopes on dolomite formation. Recorded from restricted areas in the northern Cape and the Transvaal.

TRANSVAAL.—Pietersburg: Chuniespoort, *Codd & Verdoorn* 10461. Potchefstroom: Oudedorp, *Van Wyk* 1473. Potgietersrust: about 3.5 km NE of Potgietersrust, *Codd & Verdoorn* 10386. Pretoria: Hennops River, *Verdoorn* 2468.

CAPE.—Griqualand West: Knochbarragh, *Bruckner* 246.

A study of Rehmann's route when he collected the type of this species shows that the locality 'Elands-river Drift' was most probably in the northern part of the Pretoria District, north-east of Rust de Winter.

The herbarium sheet of *Schlechter* 4322 from the Transvaal Museum, now in the National Herbarium, Pretoria, has mounted on it a mixture of this species and *M. prostrata*. Another sheet of the same number, *Schlechter* 4322, which has been in the National Herbarium for many years, is purely *M. transvaalensis*, i.e. all the leaves are crenate-dentate and coarsely stellate on the upper surface (not entire with simple subappressed, long hairs or glabrous on the upper surface).

In Engler's Monographieen Afrikanischer Pflanzen, K. Schumann describes *M. transvaalensis* Szyszyl. as having the upper surface of the leaves 'apresse pilosis' which describes those of *M. prostrata*. It is difficult to explain this for he cites only *Rehmann* 4940, the type number. The sheet in the Kew Herbarium of *Rehmann* 4940 has the leaves stellate-pubescent on the upper surface as described by Szyszylowicz, the author of the species.

9. *Melhania rehmannii* Szyszyl., Polypet. Thalm. Rehm. 138 (1887)*, sphalm. *rehmannii*; K. Schum. in Engl. Monogr. Afr. Pfl. 5–10 (1900); Burt Davy, Fl. Transv. 1: 46 & 261 (1926); Wild in F.Z. 1: 53 (1961); M. Friedrich et al., F.S.W.A. 84: 26 (1969). Type: Transvaal, Klippan, *Rehmann* 5220.

M. griquensis H. Bol. in J. Linn. Soc., Bot. 24: 172 (28th Nov. 1887) excl. *Orpen* sub *Bolus* 6045 for the greater part. Type: Cape, Asbestos Mtns in kloof, *Burchell* 2050 (K, holo.; PRE!).

M. rupestris Schinz in Bull. Herb. Boissier ser. 2, 2: 1008 (1902); M. Friedrich et al., F.S.W.A. 84: 26 (1969). Type: S.W.Africa., Oanop near Rehoboth *Fleck* 19a (Z).

Shrublet, low, usually under 30 cm tall, many stems from a woody base, new growth tomentose with ashy-grey, bunched, stellate and simple rather long hairs. *Stipules* subulate, about 7 mm long, usually turning a dark colour. *Leaves* ovate-oblong, oblong or obovate-oblong, 1–4 cm long, 0.8–2.3 cm broad, on both surfaces thickly ashy-grey stellate-tomentose at first, becoming thinly so, more or less truncate at the apex, rounded to broadly cuneate at the base, coarsely crenate-dentate; petiole 0.3–1.5 cm long. *Inflorescence* axillary, flowers usually solitary on slender cernuous pedicels, 5–10 mm long. *Epicalyx-bracts* broadly ovate about 5 mm long, oddly shaped, usually with a short basal claw, apex acute or rounded, ashy tomentose on both surfaces. *Calyx* with lobes lanceolate, about 7 mm long and 2.5 mm broad, dorsally tomentose pubescent, glabrous on inner face except at the tip. *Petals* orange-yellow, about 6 mm long, usually shorter than the calyx. *Stamens* almost as long as the ligulate, 3 mm long staminodes. *Ovary* subglobose, tomentose in upper half; style about 2–5 mm long, branches about 1.5 mm long; ovules 2–3 in a cell. *Capsule* densely tomentose with mixed pubescence.

Found in bushveld, sandy flats or rocky ridges in dry country. Recorded from the north-western Cape, Swaziland, the central and northern Transvaal, Bot-

swana and South West Africa. Also occurs in Zimbabwe.

S.W.A.—Gobabis: *Liebenberg* 4627; Keetmanshoop: Brunau, Farm Kochena, *Giess & Muller* 11889.

BOTSWANA.—Central District: N.E. corner of the Makarikari Pan; O. West 9864. Ganzl District: gate between S.W. Africa & Botswana, Mamuno, *Brown Manuno* 15. Ngamiland District: Mawabu Pan, *Burger* 1010. S.E. District: Boteti delta, N.E. of Mopipi, *Standish-White* 15.

TRANSVAAL.—Groblersdal; near Marble Hall *Codd & Verdoorn* 10870. Lydenburg: Sekukuneland, farm Lordskraal, *Barnard & Mogg* 977. Pilgrims Rest: K.N.P., Acornhoek, *Gertenbach* 5413. Potgietersrust: 21 km from Roedtan on road to Grass Valley, *De Winter* 2222. Rustenburg: ± 5 km S.E. of Rooibokkraal, *Leistner* 3176. Soutpansberg: near Sandriver, *Schlechter* 4590; Dongola Reserve, *Verdoorn* 2112.

SWAZILAND.—Big Bend, *Bayliss* BS 2720.

CAPE.—Beaufort West: ± 21 km S. of Layton, *Acocks* 23541. Hay: Asbestos Mts, *Burchell* 2050; Postmasburg, *Esterhuysen* 881. Herbert: Christian's Drift, *Leistner* 1998. Kimberley: Davis's Drift, ± 53 km W. of Kimberley, *Leistner* 1220. Kuruman: between Khosis & Maremane, *Esterhuysen* 2396.

As explained by Wild in Flora Zambesiaca, the confusion between *M. rehmannii* and *M. griquensis* (now pro parte under *M. virescens*) was initiated by H. Bolus, the author of *M. griquensis* who, although basing his description on the Orpen specimen from Griquatown (hence *griquensis*), cited *Burchell* 2050 from the Asbestos Mountains as the holotype: he saw this specimen at Kew in 1881 and mistakenly considered it to be conspecific with the Orpen specimen. Subsequent taxonomists such as K. Schuman, Wild and Burt Davy all agreed that two taxa were involved, for although closely related, they were readily distinguished by the epicalyx bracts which were subulate to linear in the Griquatown specimen and broadly ovate in *Burchell*'s specimen from Asbestos Mountains. Following these taxonomists, it has become necessary to relegate *M. griquensis* sensu stricto to synonymy of *M. rehmannii*, and *M. griquensis* (two parts as to the description and Orpen specimen) to *M. virescens* (K. Schum.) K. Schum., the first published synonym.

For further distinguishing features and notes on distribution see under *M. virescens*.

10. *Melhania virescens* (K. Schum.) K. Schum. in Engl., Monogr. Afr. Pfl. 5: 6 (1900); M. Friedrich et al., in syn. in F.S.W.A. 84: 25 (1969). Type: South West Africa, Walvis Bay, Otjatambi, *Luderitz* 117.

M. griquensis H. Bolus in J. Linn. Soc., bot. 24: 172 (28 Nov. 1887) partly as to *Orpen* sub *Bolus* 6045 for the greater part; — var. *virescens* K. Schum. in Verh. bot. Ver. Prov. Brandenb. 30: 239 (1888). Type as for *M. virescens*.

M. bolusii Burt Davy. Fl. Transv. 1: 46 & 261 (1926).

Small bushy shrublet with a perennial rootstock, 5–30 cm tall, annual growth arising from the base, young branches grey tomentose. *Stipules* subulate, 5–10 mm long, usually pubescent with grey crisped hairs. *Leaves* with the blade often silvery grey-stellate-tomentose, the upper surface becoming thinly so or glabrescent, lower surface densely grey stellate-tomentose and sometimes with scattered glands as well, oblong-elliptic, 2 × 1, 2–5 × 2.5 cm, varying in texture from rather thin to rather thick, subtruncate or subrounded at the apex, rounded to somewhat cuneate at the base, margins crenate-dentate, lateral veins prominent and running into the lobes; petiole 5–15 mm long. *Inflorescence* axillary, usually 1-flowered, rarely 2-flowered, peduncle short and straight 2–5 mm long, pedicels, if present, up to 2.5 mm long. *Epicalyx-bracts* linear-subulate, 5–10 mm long, shorter than the calyx-lobes, grey stellate-tomentose on both surfaces. *Calyx* with lobes lanceolate, acuminate, 8–14 mm long, 3 mm broad,

*It has not been possible to establish the exact date in 1887 when the description of the species *M. rehmannii* Szyszyl. appeared, but it is assumed that it would not have been later than 28th November when *M. griquensis* H. Bol. was published.

grey tomentose dorsally. *Petals* bright yellow, 6–12 mm long, shorter than the calyx. *Stamens* slightly shorter than the ligulate stamens. *Ovary* globose, densely stellate-tomentose; style 2–7 mm long, sometimes with a twist, branches 0.5–1 mm long. *Capsule* densely stellate-tomentose; seeds usually 4 in a cell.

Found in limy soils in the northern Cape, the Transvaal, Botswana and South West Africa.

S.W.A.—Gobabis: Witvlei, Basson 102. Grootfontein: Gautscha's Pan, Story 6224. Grunau: Gembokvlakte, Le Roux 663. Karibib: ± 4.3 km E. of Wilhelmstal, De Winter 2684. Maltahöhe: Buellspoor Mtn, Srey 2334. Okahandja: Bradfield 165. Okavango: Okosongomingo, Holzhammer 206. N.E. of Otjiwarongo, De Winter 2832. Outjo: Outjo Townlands, De Winter 3040. Rehoboth: Kalkrand, Acocks 18162. Windhoek: Farm Gamman, Wanniorp 122.

BOTSWANA.—Kweneng District: Takatshanane Pan, Wild 5089. Nagamitland District.: Malie Rogoni, Curson 170.

TRANSVAAL.—Potgietersrus, 12.2 km N. of Grass Valley on road to Zebediela, De Winter 2237. Lydenburg: Farm Boskloof, Fourie 5/98.

CAPE.—Barkly West: ± 3.2 km W. of Borrelskop edge of Kaap Plateau, Acocks 219. Griqualand West: Boetsap, Brueckner 286. Hay: Floradale, Esterhuysen 2304. Kuruman: Cotton End, Esterhuysen 2170. Mafeking: Molopo Native Reserve, Peeters, Gericke & Burelli 224. Taung: Thoming, Rodin 3423. Vryburg: Taljaard Nature Reserve, MacDonald 77/22.

The confusion that existed between this species and *M. rehmannii* is understandable for, until one has recognized the features that distinguish them, these species look very much alike. The specimen on which Bolus based the greater part of his description of *M. griquensis*, i.e. *Orpen* sub *Bolus* 6015, is a mixed gathering. Four of the portions have the linear-subulate epicalyx bracts as described by Bolus, and the fifth, on the left hand side of the sheet, the ovate bracts of *M. rehmannii*. The distribution of these two species overlap in the northern Cape and parts of the Transvaal. A further distinguishing feature is that the peduncles in *M. virescens* are short (usually shorter than the petiole) and suberect and the pedicels, if present, are also short and suberect, whole in *M. rehmannii* the peduncles are somewhat longer (about as long as or longer than the petiole) and the pedicels, if present, longer, thinner and cernuous.

With regard to the distribution, as mentioned above, these species overlap in the northern Cape and the Transvaal, but *M. virescens* extends further westward in South West Africa. According to collectors' notes *M. virescens* is restricted to limy soil, while *M. rehmannii* is not so restricted and is much more widespread.

The specimens added by N. E. Brown to Bolus's original description of *M. griquensis*, namely *Burchell* 2385, *Holub* s.n. *Rehmann* 5220 are all *M. rehmannii*.

11. *Melhaniea burchellii* DC., Prodr. 1: 499 (1824); Harv. in F.C. 1: 222 (1860); Burtt Davy, Fl. Transv. 1: 260 (1926); Wild in F.Z. 1, 1: 530 (1960); M. Friedrich et al. in F.S.W.A. 84: 24 (1969). Type: Cape, Kuruman District, *Burchell* 247.

M. serrata Schinz in Bull. Herb. Boissier ser. 2, 2: 1007 (1900). Type: Okahena, Dinter 499.

M. albicans Bak. f. in J. Bot. Lond. 39: 123 (1901); Burtt Davy Fl. Transv. 1: 260 (1926). Type: Transvaal, 'Pilgrims Rest' (more likely near Buttons Kop, Pietersburg District), *Greenstock* s.n. (K. holo.; PRE, photo.).

M. dinteri Engl. in Bot. Jb. 55: 350 (1919). Syntypes: S.W. Africa, several specimens including *Dinter* 645 & 2705 from Gobabis.

Plant subherbaceous, from a woody rootstock, low, up to about 90 cm tall, branches many, erect

ascending new growth densely stellate tomentose with long and short hairs, hairs sometimes foxy. *Stipules* subulate 3–10 mm long, tomentose but soon drying, curving and deciduous. *Leaves* elliptic-oblong (on flowering branches) narrowly oblong to linear oblong (on shoots), blade 3–10 cm long, 0.4–2 cm broad, shallowly to fairly distinctly toothed in the upper half stellate-tomentose on both surfaces, with short and long greyish hairs; petiole 3–17 mm long. *Inflorescences* axillary, 2–several-flowered, sometimes reduced to 1 flower, peduncle 1–6 cm long, pedicels 0.4–1 cm long; in some single-flowered inflorescences the peduncle and pedicel are indistinguishable, in others the articulation is obvious. *Epicalyx-bracts* linear-lanceolate to lanceolate, 7–11 mm long, up to 3 mm broad, the central usually the broadest stellate-tomentose on both surfaces with long and short hairs. *Calyx* with lanceolate lobes, slightly longer than the epicalyx 10–15 mm long, stellate-tomentose without, glabrous within. *Petals* yellow about 5 mm long, ligulate stamens about 7 mm long, staminal tube about 1.5 mm long. *Style* 2–4 mm long, branches about as long as the style. *Ovary* tomentose with short and long off-white hairs. *Capsule* sub-globose to oblong-ovoid, stellate-tomentose with short and long hairs, up to 12 mm long.

Found in hot, dry parts of the north-western Cape, the Transvaal, Orange Free State, South West Africa and Botswana. Also occurs in Zimbabwe.

S.W.A.—Gobabis: 80 km S.E. of Sandveld, Basson 98. Outjo: Etosha National Park, Le Roux & Grobler 1238.

BOTSWANA.—Ghanzi: 8 km N. of Kang, Wild 5052. Kgalagadi: Kalahari Park, E. of Swartpan, Van der Walt 5748. Kweneng: Khutse Reserve, Liebenberg 8986.

TRANSVAAL.—Pietersburg: Commonage, Acocks & Hafström 962. Potgietersrus: about 16 km NE of Potgietersrus, Codd & Verdoorn 10390.

O.F.S.—Hoopstad: Bultfontein, O'Connor 126.

CAPE.—Barkly West: between Jacobs Rush & Sydney, Acocks 1556. Gordonias: Gembok National Park, Leisner 1007. Herbert: near Jacobs Rush, Acocks & Hafström H.1016. Kuruman: Cotton End, Esterhuysen 2237. Vryburg Tosca, Peeters, Gericke & Burelli 236.

In the Transvaal this species is very common between Potgietersrus and Pietersburg. The form which occurs here agrees with the description of *M. albicans*, but no grounds can be found for separating it from *M. burchellii* in spite of the disjunct distribution and the difference in habitat. In the Transvaal it grows on a heavy gravelly loam soil which is very different from the loose sand in which it is found in the north-western Cape. It may be noted that the type locality of *M. albicans* is given as Pilgrims Rest. The Rev. William Greenstock, who collected the original specimen, spent some time with Edward Button at Eersteling Mine, between Potgietersrus and Pietersburg, before proceeding to Pilgrims Rest. The plant has not been found at Pilgrims Rest again and it is considered that Greenstock collected this specimen in the neighbourhood of Eersteling. Several similar cases are known where species based on Greenstock specimens have been attributed to Pilgrims Rest, but subsequent investigation has shown that they were without doubt collected in the Eersteling area.

In the Flora Capensis under *M. burchellii* Miss Owen's specimen is cited as coming from 'Zooloo Country'; this is probably another case of the several instances where Miss Owen's specimens, collected after she had left Zululand (that is, after the Dingaan massacre), were labelled as from Zululand, whereas they probably were from the Kuruman or Zeerust Districts.

Regarding another citation in the Flora Capensis, namely Zeyher from the 'Aapies River', it is doubtful whether this locality is correctly cited, since this species has not been found near Pretoria.

Although none of the syntypes of *M. dinteri* has been seen, the description best fits the specimens in this taxon.

12. *Melhania damarana* Harv. in F.C. 2: 590 (1862); M. Friedrich et al., F.S.W.A. 84: 25 (1969). Type: South West Africa, Damaraland, *Elliott* s.n.

M. ovata var. *oblongata* K. Schum. in Engl., Monogr. Pfl. 5: 7 (1900), pro parte as to Marloth 1314.

Shrublet, 30–60 cm tall, with 1 or more erect or suberect stems from a woody base; branchlets long, erect or ascending, new growth stellate-tomentose with minute reddish stellate scales obvious in parts. *Stipules* subulate 5–10 mm long. *Leaves* variable in texture, shape and size, broadly to narrowly ovate-oblong or narrowly oblong, 2–7 cm long, 1–4,3 cm broad, from irregularly and coarsely crenate to finely and regularly toothed, rounded or obtuse at the base and sometimes obscurely cordate at the point of attachment, broadly rounded or slightly narrowing to an obtuse or acute apex, densely to subdensely stellate-tomentose or finely stellate-pubescent on both surfaces; petiole 1–2,5 cm long. *Inflorescence* axillary, 1–3-flowered; peduncle straight, persistent, 1,5–4,5 cm long, pedicels 5–1,5 cm long. *Epicalyx-lobes* lanceolate to broadly lanceolate-acuminate, acute, 7–11 mm long, 2,5–3 mm broad, tomentose with grouped hairs on both surfaces. *Calyx-lobes* lanceolate-acuminate, acute or narrowed into a subulate apical portion, 8–16 mm long, 3–3,5 mm broad, tomentose on the outer surface. *Petals* yellow, sometimes pale yellow, almost as long as the calyx or slightly longer, 7–20 mm long. *Stamens* with filaments about 2 mm long, anthers 5 mm long, ligulate, staminodes 6–11 mm long. *Ovary* subglobose, stellate-tomentose with short and long, creamy to pale yellow hairs; style 2–7 mm long, branches, 2–3 mm long; ovules 6 in a cell. *Capsule* globose to oblong-globose, stellate-tomentose, 5–12 mm long.

Occurs throughout the length of western South West Africa with one record to date from the northern Cape. Found mostly in dry conditions on the western side of the plateau at the Namib fringe.

S.W.A.—Kaokoland: W. of Etanga, *De Winter & Leistner* 5411. Karasburg: Mundis, *Auret* 5601. Luderitz: farm Weissenborn, *Kings* 2377. Maltahöhe: Abendruhe, *Oliver, Muller & Steenkamp* 6568. Omaruru: Numas Valley, *Wiss* 1415. Outjo: Otjiwarongo, *Giess* 8524. Rehoboth: Buffelspoort, *Tölken & Hardy*, 668. Tsumeb: 6 km S.W. Tsumeb *Giess* 8663. Walvis Bay: foot-hills Erosgebirges, *Merxmüller & Giess* 3566.

CAPE.—Hay: Rietkloof, *Acoks* 8520.

This species approaches *M. suluensis* from eastern Natal. For main distinguishing features see the key, p. 264.

M. damarana also resembles forms of *M. ovata* auct. found in tropical Africa with the type from South America, the principal distinguishing feature being the shape of the epicalyx-bracts, which are linear-subulate in *M. ovata* and lanceolate to broadly lanceolate in *M. damarana*.

13. *Melhania suluensis* Gerstner in JI S. Afr. Bot. 12: 37 (1946). Type: Natal, Eshowe, near Dhlangubo store, *Gerstner* 2888 (BOL, holo.).

Suffrutex, main stem erect with many slender branches (no new growth from the base), 60–90 cm tall, new growth off-white tomentulose *Stipules* subulate, about 3 mm long, persistent. *Leaves* comparatively thin-textured, broadly ovate to ovate-oblong, sometimes broadly oblong, 1–4,5 cm long, 0,7–2,5 cm broad, very shortly stellate-tomentose on both surfaces, lower surface silvery-grey and sometimes with reddish brown stellate hairs from lepidote scales scattered on the raised nerves, upper surface darker and more uniformly stellate-tomentulose, rounded to shallowly cordate at the base, broadly rounded or rarely subacute at the apex, margins shallowly crenate-dentate; petiole 0,5–1,5 cm long. *Inflorescence* axillary 1–2-flowered, peduncles slender, 0,5–2 cm long, pedicels 0,3–1,2 cm long, in single-flowered inflorescence the peduncle and pedicel are indistinguishable and up to 2 cm long. *Epicalyx-bracts* lanceolate-acuminate to ovate-lanceolate (not broadest at the base), 6–9 mm long, 2,5–3,5 mm broad, felted on both surfaces with short off-white stellate tomentum. *Calyx* with lobes lanceolate-acuminate, about 9 mm long and 3 mm broad, dorsally stellate-tomentulose. *Petals* lemon-yellow, about 10 mm long, 5–8 mm broad at the apex. *Stamens* with filaments about 0,5 mm long, anthers about 2,5 mm, united portion, 1 mm long, staminodes ligulate, about 5 mm long. *Ovary* subglobose, stellate-tomentose; style 3–7 mm long, branches about 1,5 mm long; ovules about 5 in a cell. *Capsule* subglobose, about 6×6 mm, densely and shortly stellate-tomentose.

Found in alluvial soil or on rocky slopes in dry bushveld at altitudes of 3–170 m. Recorded from the coastal area of Natal.

NATAL.—Camperdown: Umgeni Valley, *Forbes* 1259 (NH). Entonjaneni: Nogeys, *Venter* 3728. Eshowe: near Dhlangubo store, *Codd & Verdoorn* 10174. Hlabisa: Hluhluwe Game Reserve, *Scott-Smith* 71. Ngotshe: Itala Nature Reserve, *Brown & Shapiro* 445. Ubombo: Mkuze Poort, *Ward* 4071.

M. suluensis is closely related to *M. damarana*, which occurs in South West Africa, west of the escarpment. Besides this difference in distribution the main distinguishing features are given in the key on p. 264.

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When reviewing the genus *Melhania* in 1962, I was fortunate in being able to enlist the help of Dr O.A. Leistner, who was the South African Liaison Officer at the Royal Botanic Gardens, Kew: he kindly examined specimens for me at Kew and the British Museum (Natural History) and solved the problems submitted to him. I am indeed grateful to Dr Leistner for his assistance.

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The loan of herbarium material from Rhodes University and the University of the Orange Free State was much appreciated.

UITTREKSEL

Die 13 spesies van Melhania in suidelike Afrika is hersien. Een van die probleme wat opgelos is, is 'n ou een betreffende die identiteite van M. rehmannii Szyszyl. en M. griquensis H. Bol. M. griquensis, in die enge sin, word in die sinonimie van M. rehmannii geplaas.

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The genus *Waltheria* in southern Africa

I. C. VERDOORN*

ABSTRACT

Waltheria indica L., the only species of *Waltheria* represented in southern Africa, is revised. This species, which occurs throughout the tropics and subtropics of the world, is found abundantly in the northern Cape, Swaziland, northern Natal, Transvaal and northwards through South West Africa/Namibia and Botswana. Throughout its wide distribution the species is uniform. A scrutiny of herbarium specimens revealed that what appeared as a distinct species or subspecies was without doubt an abnormality, probably caused by insect injury.

RÉSUMÉ

LE GENRE WALTHERIA EN AFRIQUE AUSTRALE

Waltheria indica L., la seule espèce de *Waltheria* représentée en Afrique australe, est révisée. Cette espèce qui se trouve d'un bout à l'autre des tropiques et sub-tropiques du monde, est trouvée en abondance au Cap septentrional, au Swaziland, au nord du Natal, au Transvaal et vers le nord, à travers le Sud-Ouest africain/Namibie ainsi qu'au Botswana. Malgré sa distribution très dispersée, l'espèce est uniforme. En scrutant les spécimens des herbiers, il se révèle que ce qui apparaissait comme des espèces ou sous-espèces distinctes est sans aucun doute une anomalie probablement causée par dégâts d'insecte.

WALTHERIA

Waltheria L., Sp. Pl. 673 (1753); Gen. Pl., ed. 5: 304 (1754); Harv. in F.C. 1: 180 (1860); Benth. & Hook. f., Gen. Pl. 1: 224 (1862); Wild in F.Z. 1: 536 (1960); M. Friedrich et al. in F.S.W.A. (1969); R. A. Dyer, Gen. 1: 365 (1975).

Lophanthus Forst., Char. Gen. 27, t. 14 (1776).

Astropus Spreng., Neue Entd. 3: 64 (1822).

Shrublets, subherbaceous at first, pubescent with stellate, tufted and simple hairs. *Leaves* simple, crenate-dentate, petioled, stipulate. *Inflorescence* axillary and terminal, flowers in cymes, often congested, or heads of flowers racemously or paniculately disposed. *Bracts* often present. *Calyx* 5-lobed. *Petals* 5, marcescent. *Stamens* 5, united at the base; anther-cells parallel. *Ovary* 1-celled; ovules 2 anatropous; style somewhat excentric, clavate or fimbriate at the apex. *Capsule* usually 1-seeded; seed ascending, endospermous; embryo straight.

Found in the tropics and subtropics of both the east and the west with the greatest concentration of species in South and Central America. Of the 67 known species only 7 occur in the Old World and one of these is common to the Old and New World. This common species, *W. indica*, is the only species found in southern Africa.

The generic name was given in honour of Augustin F. Walther of Leipzig, a contemporary of Linnaeus, remembered especially for his botanic garden.

Waltheria indica L., Sp. Pl. 673 (1753); R. Br. in Tuckey, Narrat. Esp. river Zaire, App. 5: 484 (1818); Mast. in Fl. Brit. India 1: 374 (1874); Harv. in F.C. 1: 180 (1860) Wild in F.Z. 1: 536 (1960); F.S.W.A. 84: 28 (1969). M. K. Scott in Bothalia 12 452 (1978). Type: India, Linn. Herb. 852.2.

W. americana L., Sp. Pl. 673 (1753); Mast. in F.T.A. 1: 235 (1868); K. Schum. in Engl., Monogr. Afr. Pfl. 5: 45 (1900); Burtt Davy, Fl. Transv. 1: 268 (1926). Type: America, Linn. Herb. 852.1. — var. *indica* (L.) K. Schum., l.c. 547 (1900). Type as for *W. indica* L. — var. *subspicata* K. Schum., l.c. 547 (1900). Types: several syntypes including Schinz s.n., South West Africa/Namibia.

Shrublet, subherbaceous at first, stems slender, hirsute, with stellate, tufted or simple bulbous based hairs, erect to spreading and bushy, 30 cm to 1 m tall, sometimes taller. *Stipules* linear-acute, 3–10 mm long. *Leaves* petioled; blade ovate, ovate-oblong, oblong to narrowly oblong, 2–10 cm long, 1–4.5 cm broad, crenate-dentate, rounded, subtruncate or broadly subacute at the apex, nerves prominent beneath, laxly to densely stellate pubescent or hirsute with bulbous-based hairs on both surfaces; petiole hirsute, 0.6–3.5 cm long. *Inflorescence* axillary, cymose, usually tightly congested rarely (abnormal)? sublux, sometimes heads of flowers appear to be racemously or paniculately disposed because the subtending leaves are much reduced or absent. *Bracts* usually 3 to a flower, linear acute, 3.5–5 mm long, differing slightly in width but mostly under 1 mm wide, dorsally hirsute. *Calyx* hirsute, 10-nerved; tube turbinate, about 2.5 mm long; lobes deltoid acute to deltoid acuminate, about 2 mm long. *Petals* yellow, 'orange yellow', turning reddish brown at maturity, oblong-cuneate to spatulate, about 4 mm long, 1.25 mm broad, dorsally sparsely hairy, adhering at the base to the stamen base, deciduous from the base but persisting for some time around the capsule, the lower portion held within the calyx-tube. *Stamen* opposite the petals, shorter than the full grown petals; filaments membrane-margined at the base or, more usually, almost to the apex, more or less united along the membrane edge, the apical unwinged filiform portion shortly and sparsely pubescent and at certain stages contorted; anthers erect or (especially in abnormal specimen) horizontal, cells parallel, subacute at both ends. *Ovary* 1-celled, obovoid slightly flattened, broadest at the apex, densely hirsute in upper portion; style excentric, about 3 mm long, sometimes rather contorted, fimbriate at the apex; ovules 2, ascending, anatropous. *Capsule* thin-walled, about 4 mm long, almost 2 mm broad at the apex, hirsute on upper portion, 1-seeded or rarely the second ovule developing as well; seed obovoid; embryo straight.

Found in open grassland, on rocky slopes, along rivers, in waste places, and rarely in woodland. Recorded from the northern Cape and Natal northwards through the Transvaal, South West Africa/Namibia and Botswana to tropical Africa. Also oc-

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curs elsewhere in the tropics and subtropics of the Old and New Worlds.

S.W.A./NAMIBIA.—East Caprivi: Katima Mulilo, *Killick & Leistner* 3058. Gobabis: Farm Amasib, *Merxmüller* 1088. Grootfontein: Amrib, *Schoenfelder* S.554. Karibib: Farm Ameib, *Kinges* 3306. Kavango: Tsozana, *Giess* 9958. Okahandja: Quickborn, *Bradfield* 85. Owambo: Oshigambo, *Sylvia Soeni* s.n. or near Ruacana, *De Winter & Giess* 7084. Tsumeb: 50 km N. of Tsumeb, *Goldblatt* 1938.

BOTSWANA.—Central distr.: Dikolodi East, *Kerfoot* 8015. Chobe: Lower Ngwezumba, *Miller* 13187. Ganzi: Mamono Ridge, *Mason & Boshoff* 292. Kgalegadi: 16 km N. W. of Tsabong, *Leistner* 3069. Kweneng: 412 km N. W. of Molepolole, *Story* 4974. Ngamiland: Boro Floodplain, *Biggs* M. 588. Ngwaketse: Plarging, *Miller* B. 865. South East: 8 km N. of Gaborone, *Cox* 5059.

TRANSVAAL.—Barberton: Tonetti, *Thorncroft* 76. Carolina: Nelsberg, *Taylor* 1990. Groblersdal: Marble Hall, *Pienaar* 519. Letaba: Westfalia Estate, *Scheepers* 302. Lydenburg: Farm Sterkspruit, *Galpin* 12174. Marico: Lekkerlach, *Louw* 251. Nelspruit: near Pretoriuskop, *Codd & De Winter* 4917. Pietersburg: Shilovane, *Junod* 4891. Pilgrims Rest: Sabie River, *Van der Schiff* 41. Potgietersrust: Percy Fyfe Nature Reserve, *Huntley* 1679. Pretoria: N. of Pretoria at turn off to Rust de Winter Dam, *Tölken* 1224 (partly abnormal). Rustenburg: 3,2 km S. of Rooibokkraal P. O., *Leistner* 3210. Soutpansberg: Tokwe, *Dreyer* in *TRV* 21616 (partly abnormal); S. of Punda Milia, *Schlechter* 9291. Waterberg: Nylstroom, *Repton* 530. Witbank: Mapochsdrift, *Du Plessis* 411.

SWAZILAND.—Hlatikulu: Big Bend, *Compton* 30278. Manzini: Sipofaneni, *Compton* 29713.

NATAL.—Entonjaneni: Melmoth, *Gerstner* 4306. Hlabisa: Hluhluwe Game Reserve, *Ward* 1855. Ingwavuma: Ndumo Game Reserve, *Hancock* 7. Lower Tugela: Mandeni, *Edwards* 1360. Lower Mfolozi: Mfolozi Game Reserve, *Ward* 4614. Marico: Motsweddi, *Peeters, Gericke & Burelli* 478. Ngotshe: Itala Nature Reserve, *Brown & Shapiro* 309. Ubombo: Mkuze, *Galpin* 13706.

CAPE.—Hay: Rietkloof, *Acoccks* 8518. Kuruman: Seremoneng, *Acoccks* 2280. Mafikeng: 'Ferndale', *Brueckner* 451. Postmasburg: Nchwaneng, *Leistner* 2205. Vryburg: Vryburg, *Mogg* 8889.

This species, which is widely spread in all tropical and subtropical regions of the world, is fairly uniform in its South African localities. Characterized by small yellow flowers, with hirsute calyces, congested in axillary glomerules, it is readily recognized. Sometimes the glomerules or 'heads' of flowers appear to be racemously arranged or in panicles. This is because they grow on slender side branches with the subtending leaves either much reduced or absent.

Among the many specimens examined, there is one from the northern Transvaal in parts of which, the

major part, the flowers are in subaxillary cymes up to 6 cm long. This at once gives the specimen a different aspect. It was found, too, that the parts of the flowers also differed from the normal. The filaments were not membrane-margined for most of their length, but only at the very base if at all, the anthers were horizontal, not erect, and the ovary somewhat acuminate to the oblique apex instead of broadest and more or less truncate at the top. This gave the impression that a distinct species was involved. But right at the base of the specimen on the same branch was a typical, congested cyme and the flowers on it are typical. What caused the abnormality and why it should be accompanied by a difference in flower structure remains a problem, but it may be due to insect injury.

Waltheria indica L. and *W. americana* L. were published simultaneously in 1753. Since R. Brown was apparently the first to unite the two taxa under the name *W. indica*, his choice must be followed (Art. 57 of ICBN, 1978) and this is so done in this treatment.

ACKNOWLEDGMENTS

I am indebted to members of the staff of the Botanical Research Institute for their very helpful assistance with dissections, drawings and excursions to examine the species in the field.

UITTREKSEL

Die enigste spesie van Waltheria wat in suidelike Afrika verteenwoordig is, word hersien. Hierdie spesie wat dwarsdeur die tropiese en subtropiese dele van die wêreld voorkom, word dikwels in die noordelike Kaap, Swaziland, noordelike Natal, Transvaal en noordwaarts deur Suid-Wes Afrika/Namibia en Botswana aangetref. Hierdie spesie varieër min dwarsdeur sy wye verspreidingsgebied.

'n Ondersoek van herbariumeksemplare het getoon dat sekere monsters wat gelyk het na verteenwoordigers van 'n afsonderlike spesie of subspesie in werklikheid sonder twyfel 'n abnormaliteit vertoon wat deur insekbeskading veroorsaak is.

The genus *Cola* in southern Africa

I. C. VERDOORN*

ABSTRACT

The two species of *Cola* that occur in southern Africa are reviewed. *C. natalensis* Oliv. is endemic, but *C. greenwayi* Brenan has mainly a tropical east African distribution with the eastern Transvaal and northern Zululand specimens being the most southerly records. A study of the available material from tropical east Africa and southern Africa supports the view that *C. microcarpa* Brenan is synonymous with *C. greenwayi*.

RÉSUMÉ

LE GENRE COLA EN AFRIQUE AUSTRALE

Les deux espèces de *Cola* que l'on trouve en Afrique australe sont révisées. *C. natalensis* Oliv. est endémique, mais *C. greenwayi* Brenan a surtout une distribution tropicale Est africaine avec les spécimens du transvaal oriental et du Zululand septentrional étant ceux qui ont été enregistrés comme les plus méridionaux. Une étude du matériel disponible d'Afrique tropicale de l'Est et de l'Afrique australe soutient l'opinion que *C. microcarpa* Brenan est synonyme de *C. greenwayi*.

COLA

Cola Schott & Endl., Melet. Bot. 33 (1832); Benth. & Hook. f., Gen. Pl. 1: 218 (1862); K. Schum. in Engl., Monogr. Afr. Pfl. 5: 110 (1900); Wild in F.Z. 1: 558 (1961); nom. cons. (I.C.B.N. 1956); R. A. Dyer, Gen. 1: 365 (1975). Type species: *C. acuminata* (Beauv.) Schott & Endl.

Trees dioecious or monoecious, or occasionally with bisexual flowers. *Leaves* alternate, entire or lobed, petiolate; petioles often with a swollen apical portion (pulvinus). *Inflorescence* cymose or flowers in the axils of the leaves, or on branchlets between the leaves, solitary or clustered, sometimes on old wood;

unisexual, occasionally bisexual. *Calyx* 4–5(–6) lobed *Petals* absent. *Male flower*: stamens usually 10, united into a column, bearing sessile anthers in 1 or 2 rings around the apex, vestigial carpels often sunk in the top of the androphore column. *Female flower*: carpels (3)–4–5 (–10), cohering at first with a ring of rudimentary stamens at the base; ovules several to many per carpel; styles as many as the carpels. *Fruit* splitting into 4–5 carpels or sometimes 1 or more aborting. *Seeds* exendospermous; cotyledons thick, 2 or more.

Species over 100, all African. Two species occur in South Africa.

KEY TO SPECIES

- | | |
|--|-------------------------|
| Petiole with apical swollen portion glabrescent; fruit obovate, up to about 4 cm long, rind hard and thick | 1. <i>C. natalensis</i> |
| Petiole with apical swollen portion tomentose; fruit subglobose to oblique ellipsoid, 1 × 1,3–1,8 × 2 cm, rind at maturity rather thin and brittle | 2. <i>C. greenwayi</i> |

1. *Cola natalensis* Oliv. in Hooker's Icon. Pl. 14: 70, Plate 1390 (1882); K. Schum. in Engl., Monogr. Afr. Pfl. 5: 114 (1900); Sim, For. Fl. Cape Col. 144, Plate 17, f.3 (1907). Type: Inanda, Natal, Medley Wood 321.

Tree 3–15 m high, evergreen, monoecious or dioecious, 'bark flaking off in small patches'; branchlets glabrescent. *Stipules* early caducous, not seen except on seedlings, subulate-acuminate, ± 6 mm long. *Leaves* simple, entire; blade obovate-elliptic, usually narrowly so, shortly and broadly narrowing to, or acuminate at, the apex, narrowing from above the middle to the base, 7–20 cm long, 1–6,5 cm broad, glabrous at maturity, young leaves sparsely stellate with short hairs, midrib prominent, especially on under surface, with 7–12 or more distinct lateral nerves; petioles 1–4 cm long, with a slight thickening (pulvinus), 5–10 mm long, at the apex; pulvinus glabrescent. *Inflorescence* 1-flowered, axillary, solitary or fascicled, or from below leaves and on old wood, usually clustered on a much ab-

breviated shoot, 2 to several in a cluster; bracts at base, 1,5–2 mm long, 1,5–2 mm broad, early deciduous; pedicels 3–7 mm long, up to 1 mm diam., articulated about midway, and with scars of 1–2 bracts; densely stellate-tomentose at first, hairs short, less than 0,5 mm long, light or dark brown. *Calyx* 5-lobed almost to base, densely brown stellate-pubescent without; lobes 4–8 mm long 1,5–4,5 mm broad, lepidote within and with a few scattered brown stellate hairs in upper half. *Male flower* with staminal-tube glabrous or minutely stellate in basal portion, 1,5–5 mm long, anthers 8 in 1 row at the apex, cells parallel, 1 mm long, rudimentary ovary and 5 styles in anther ring. *Female flower* with sessile ovary, 4–5 carpellate, about 2 mm diam., with a ring of rudimentary stamens round the base; styles 5, sometimes fewer, with club-shaped recurved, stigmas; ovules 2 or 3 in each cell. *Carpels* 4–5, or by abortion fewer, obovate-globose, about 4 cm long, 3 cm diam., densely microscopically scaly and stellate-pubescent, hairs very short or worn off, rind hard (often tuberculate through insect activity), ripe fruit orange to salmon yellow, glutinous inside; seeds 2, or sometimes 3, cotyledons thick, creamy white and

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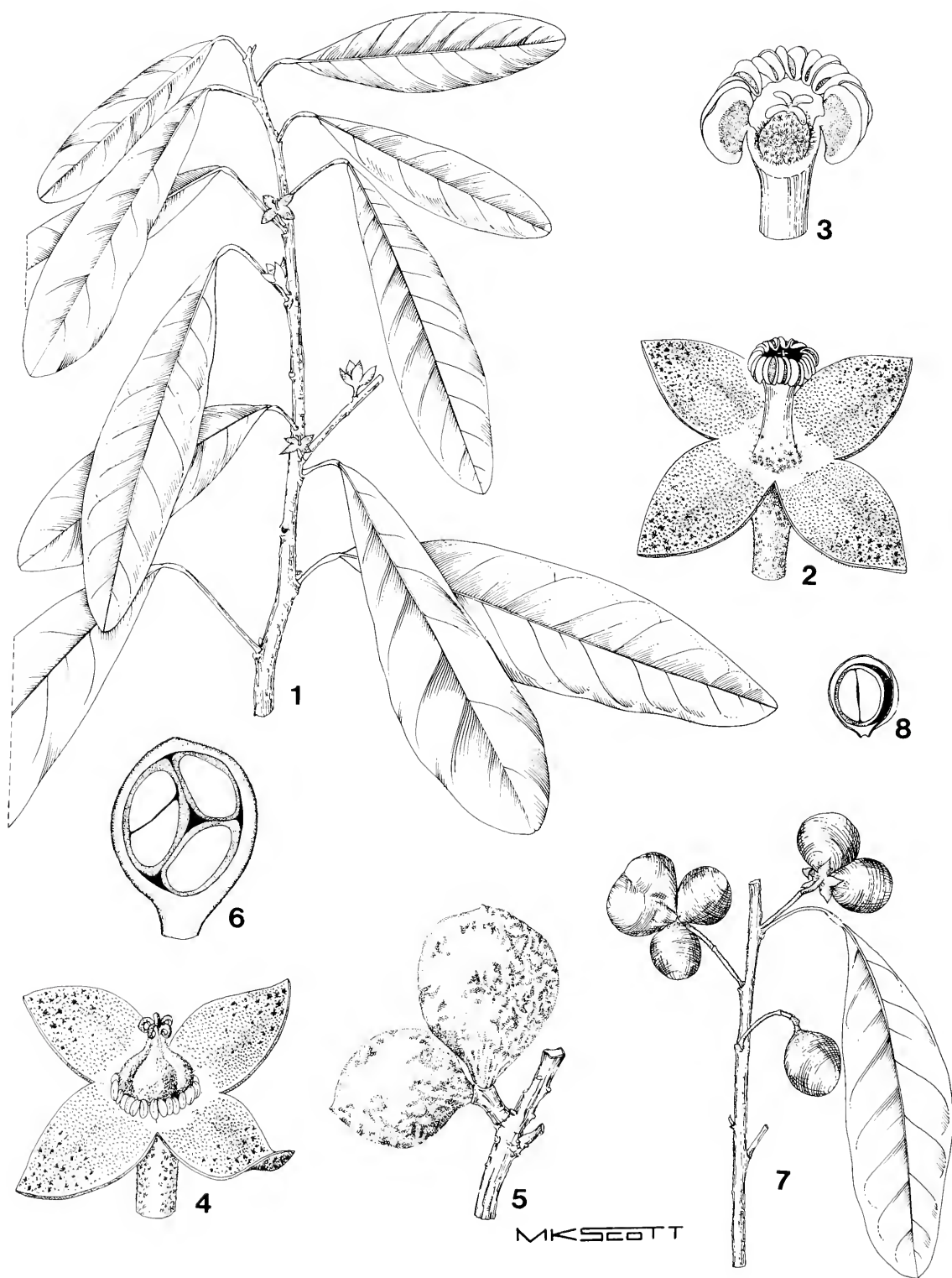


FIG 1.—*Cola natalensis* 1–6. 1, flowering twig with male flowers, $\times 0,8$ (Ward 5623); 2, male flower, $\times 5$ (Ward 5622); 3, androphore with front stamen removed to expose the rudimentary ovary, $\times 12$ (Ward 5622); 4, female flower, $\times 5$ (Moll 3211); 5, fruiting twig, $\times 0,8$ (Ward 2623); 6, longitudinal section of carpel, $\times 0,8$ (Ward 2623). *C. greenwayi* 7–8. 7, fruiting twig with comparatively smaller carpels, $\times 0,8$; 8, longitudinal section of carpel showing the comparatively thin rind, $\times 0,8$. (7 & 8, Garland sub PRE 47565.)

deep pinkish red tinged on inner face and with resinous ducts, in part minutely stellate-pubescent. Fig. 1.

Found in dense forest along coast in the Transkei and Natal as far north as Mtunzini.

TRANSKEI.—Lusikisiki: Intafufu, *Campbell*, sub *Sim* 2627. Port St Johns: Noxolweni Forest, *Mogg* 13066; St Johns River, *Pole Evans* H. 18047.

NATAL.—Durban: Bluff (?), *Medley Wood* s.n.; Inanda: *Medley Wood* 1500; Umhlanga, *Marais* 797; *Story* 4152. *Watumough* 443; *Cheadle, Johnson & Wells* 686; *Moll* 1810. Mtunzini: Ngoya Forest, *Edwards* 121.

The fruit is said to be inedible. Wood durable. Related to the tropical species *C. clavata*, but differs principally in the large, less numerous flowers. In *C. clavata*, the flowers arise from numerous abbreviated shoots on the old wood as well as in the axils of the leaves. It differs from *C. mossambicensis*, the other species that occurs in Mozambique, mainly in the texture of the leaves, the subglabrescent fruits and the glabrescent pulvinus.

2. *Cola greenwayi* Brenan in Kew Bull. 1956: 147 (1956); Wild in F.Z. 1: 560 (1960); Drummond in Kirkia 10: 260 (1975); Palgrave, Trees of Sth. Afr. 598 (1977). Type: Tanzania, Mkuzi, *Greenway* 7891 (K, holo.!).

C. microcarpa Brenan in Kew Bull. 1956: 147 (1956); Palmer & Pitman, Trees of Sth. Afr. Vol. 2, 1491 (1972). Type: Tanzania, Turiana, *Sensei* 1466 (K, holo.!).

Tree 3–20 m high, monoecious or dioecious; young branchlets russet to light cinnamon brown or grey tomentose at first, mixed with stellate or bunched hairs which fall readily. *Stipules* very soon falling, subulate-lanceolate to linear, 3–6 mm long, dark to light-brown or grey tomentose. *Leaves* simple, entire, blade elliptic to narrowly obovate-elliptic, narrowing to base and apex, 4–15 cm long, 1.4–5 cm broad, glabrous at maturity, midrib slender, prominent on both surfaces, with usually 7–18 main lateral veins, distinct to prominent on lower surface; petiole 0.5–5.5 cm long with a thickened pulvinus at the apex, tomentose throughout, with some long hairs as well, becoming glabrous except for the pulvinus which is persistently tomentose. *Inflorescence* 1-flowered, axillary, solitary or fascicled and crowded on branchlets between the leaves; flowers unisexual, rarely some bisexual, apparently dioecious (may be monoecious), arising from sessile imbricating bracts which are 1.5–3.5 mm long, densely stellate-tomentose without subsistent; pedicels about 7–20 mm long, (sometimes obscurely articulate), about midway, densely stellate-pubescent, hairs dark to light brown, short or long (as long as the pedicel is broad). *Calyx* 4–6-lobed almost to the base at flowering time, dorsally stellate-pubescent; lobes from about 5–10 mm long, 2.5–3.5 mm broad, inner face stellate-pubescent at least in upper half lepidote below. *Petals* 0. *Male flower* with staminal tube about 2.5–4.5 mm long, densely pubescent to subglabrous; anthers up to 8 in one row, sessile in a ring around the apex of the staminal-tube, rudimentary carpels and styles in the centre of the ring. *Female flower* with ovary sessile, densely stellate-pubescent, about 2 or 3 mm diam., with a ring of rudimentary stamens around the base, carpels 4–5

(3?); styles arising laterally with clavate recurved, papillose stigmas. *Carpels* 4–5 or less by abortion, orange yellow to deep orange with touch of vermilion when ripe, obliquely subglobose obliquely ellipsoid or obovate, 1×1.3 cm to 1.8×2 cm rounded on top with the remains of the style-base lateral and obscure, or forming a mucro, stellate pubescent in parts (rubs off easily) with dark to light brown hairs, long bristles, rind at maturity rather thin and brittle; seeds 1–2 (coat like that of fruit); cotyledons 2 (one smaller than the other, reddish pink tinge between them in fresh fruit); plumule stellate-pubescent.

Found in dense woodland or forests, ranging from sea level to steep mountain slopes at altitudes of 1 100 m or more. Recorded from northern Natal and eastern Transvaal. Also occurs in Mozambique and northwards in tropical east Africa.

TRANSSAAL.—Barberton: Bearded Man Mountain, farm Duurstede *Buitendag* 1110; Twello Forest Estate, ± 12 km S.E. of Barberton on road to Havelock, *Arnold* 1621; Pedlar's Bush, *Buitendag & Kruger* 0000.

NATAL.—Hlabisa: False Bay, *Ward* 3664, 3676; near Charters Creek, *Rochat* 14; Hluhluwe Game Reserve, *Ward* 2966; Dukuduku Forest *Srey* 5590. Ingwavuma: Lake Sibayi, *Vahrmeijer* 1080; *Garland* 5801. Ubombo: Lake Sibayi, *Vahrmeijer* 720.

When describing the two species, *C. greenwayi* and *C. microcarpa*, Brenan (1956) mentioned that the differences between them are small but the altitudes at which they grow differ considerably, *C. microcarpa* occurring at about 460 m, whereas *C. greenwayi* is found at altitudes between 1 600 and 2 000 m. Drummond in Kirkia (1975) sank *C. microcarpa* under *C. greenwayi* without comment. Drummond is followed here because, whereas the small differences noted between these two species are merely of degree, such as the colouring and length of the pubescence, the comparable size of the fruit and the mucro being more obvious on the carpels of one than on the other, the features considered to be diagnostic are the same. These features are the general size and shape of the flowers and the carpels and the brittle rind of the ripe fruit. According to collectors' notes, both species are at times, and in small patches, especially on the ripening carpels, suffused with 'reddish crimson' or 'orange vermilion', but this is not obvious on herb-arium specimens.

The presence of a species of *Cola* in the Barberton District, probably the southernmost limit of the genus, has only recently (1976) come to light. This is surprising, since that is an area particularly well collected as shown by the large Thornicroft collection. The probable explanation is the inaccessible nature of the forest patches on the steep mountain slopes.

UITTREKSEL

Die twee Cola-spesies wat in suidelike Afrika voorkom word hersien. C. natalensis Oliv. is endemies, maar C. greenwayi Brenan kom hoofsaaklik in tropiese Oos-Afrika voor met eksimplare uit Oos-Transvaal en Noord-Zoeloeland as die mees suidelike verspreidingsrekords. 'n Studie van die beskikbare eksimplare uit tropiese Oos-Afrika en suidelike Afrika staaf die opvatting dat C. microcarpa Brenan 'n sinoniem van C. greenwayi is.



The *Eriosema cordatum* complex. II. The *Eriosema cordatum* and *E. nutans* groups

C. H. STIRTON*

ABSTRACT

The *Eriosema cordatum* E. Mey. complex is segregated into a number of species. *E. cordatum* E. Mey. is retained as a polymorphic species and two allied species, *E. lucipetum* C. H. Stirton and *E. zuluense* C. H. Stirton are described as new. Four additional species *E. buchananii* Bak. f., *E. nutans* Schinz, *E. psoraleoides* (Lam.) G. Don and *E. parviflorum* E. Mey. are revised and excluded from the *E. cordatum* group.

RÉSUMÉ

LE COMPLEXE ERIOSEMA CORDATUM. II LES GROUPEES ERIOSEMA CORDATUM ET E. NUTANS

Le complexe *Eriosema cordatum* E. Mey. est divisé en un certain nombre d'espèces. *E. cordatum* E. Mey. est retenu comme une espèce polymorphique et deux espèces, alliées *E. lucipetum* C. H. Stirton et *E. zuluense* C. H. Stirton sont décrites comme nouvelles. Quatre espèces additionnelles *E. buchananii* Bak f., *E. nutans* Schinz, *E. psoraleoides* (Lam.) G. Don et *E. parviflorum* E. Mey. sont révisées et exclues du groupe *E. cordatum*.

INTRODUCTION

Verdcourt (1971a) included seven species in the *Eriosema cordatum* E. Mey. complex. The identity of two of these species, *E. populifolium* Harv. and *E. distinctum* N.E.Br., has already been clarified (Stirton, 1978). This paper deals with the remaining species of the complex: *E. cordatum* E. Mey., *E. nutans* Schinz, *E. buchananii* Bak. f., *E. parviflorum* E. Mey. and *E. psoraleoides* (Lam.) G. Don.

In 1975 Stirton concluded that *E. cordatum* could be segregated into five taxa which, pending further study, he named A to E. Taxon A is retained as a polymorphic species. Taxon B and taxon C are united into a new species *E. lucipetum*. Taxon D is described new as *E. zuluense*. Taxon E has already been described as *E. gunniae* C. H. Stirton (Stirton, 1981), so will not be dealt with further. The remaining species are correctly identified as *E. buchananii*, *E. nutans*, *E. parviflorum* and *E. psoraleoides*.

GROSS MORPHOLOGY OF THE SPECIES

Vegetative parts

Habit. This complex comprises perennial herbs, suffrutices and shrubs. *E. psoraleoides* is the only true shrub and often grows up to 1.5 m high. The suffrutices are low growing woody plants with annually regenerated growth points; *E. nutans*, *E. buchananii*, and *E. parviflorum*. The remaining taxa all die back completely during the winter months to regenerate aerial parts each spring. Growth form may be erect, ascending, decumbent or prostrate.

Rootstocks. All species develop perennial rootstocks which, being quite variable in form, provide excellent key characters for fieldwork, especially in the absence of flowers and fruits. *E. cordatum* is readily separated from all other species by its distinctive daucate rootstock (Fig. 1). *E. psoraleoides* has the most robust and branched rootstock (Fig. 2). There is usually a short pseudo-stylopodium at the apex of the rootstock. Root nodulation occurs in all the species treated in this paper (Grobbeelaar, Van Beyma & Todd, 1967; Grobbeelaar & Clarke, 1972; Stirton, 1975). Freshly exposed rootstocks, with roots and nodules still intact, will, if left in water for

24 hours, produce a pungent mustard-like odour. The nodules swell considerably.

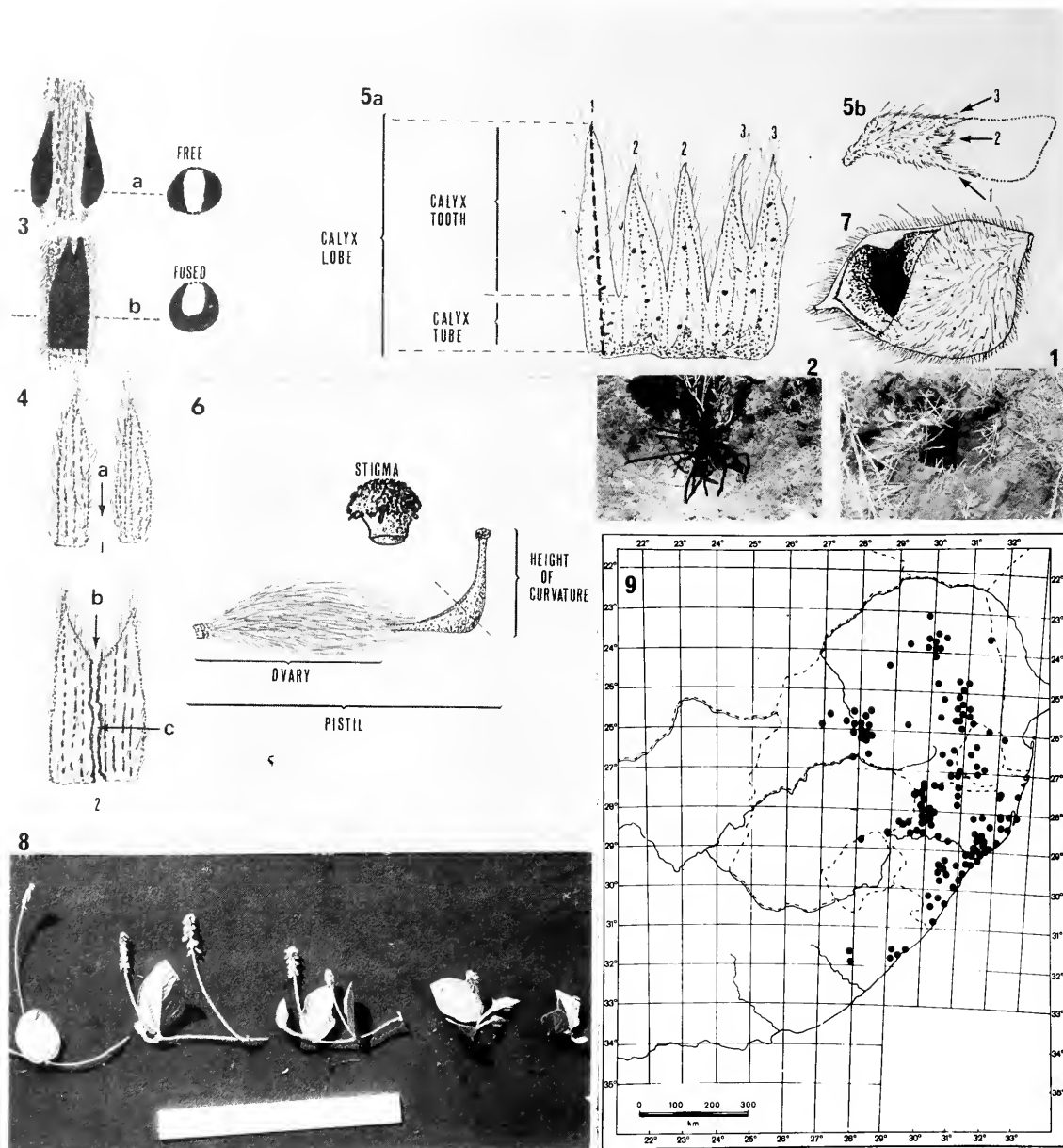
Stems. The perennial herbs have strict stems that are either terete or angular. Up to fifteen stems may arise from the short pseudo-stylopodium at the apex of the perennial rootstock. Complex branching is common in the suffrutices and in the shrub *E. psoraleoides*. Two species are worth describing in detail.

The main stem in *E. parviflorum* is very short. This results from the suppression of the leader concomitantly with the production of lateral branches. The lateral branches grow out perpendicularly to the main stem and are produced close to the ground. Their growth begins once the leader has reached approximately 50 cm in height. The side branches grow very quickly. If the leader dies back the plant assumes the shape of a low bowl. The characteristic low spreading nature of this suffrutex is possibly attributable to the sudden retardation of growth in the leader stem.

In contrast to that of *E. parviflorum* the stem of *E. psoraleoides* is erect and continues to lengthen once branching begins. However, if the leader is damaged, the lateral branches soon compete to lead. This results in the production of a short rounded shrub in contrast to the usual tall, erect, somewhat spreading shrub. Short rounded shrubs are commonly found in Kwazulu and on closer investigation the leader will be found to have been damaged by a borer insect. *E. psoraleoides* also produces tall, densely branched shrubs, with a compact appearance. This form results from the production of numerous watershoots that arise directly from the pseudo-stylopodium and this form can be expected to be found in areas subject to burning.

Vesture. The nature of the hair covering is determined by the length, direction, form, and quantity of the hairs considered collectively. As Stearn (1973) indicated, these characters should be stated individually as there are more types of vestiture than there are terms to designate them. It is most unfortunate that there is no standard hair terminology for, as Roe (1971) pointed out, this would enhance the taxonomic value of hairs. As vestiture forms a useful character in the characterization of taxa in the present study, I have decided to follow Grear's (1970) treatment of the American species of *Eriosema* by adopting Lawrence's (1960) definitions of hair types.

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FIGS 1–9. — 1, *Eriosema cordatum*, daucate rootstock, side branches absent. 2, *E. psoraleoides*, multibranched rootstock. 3, basic types of stipules found in the genus *Eriosema*: a, side view of free stipules with petiole in plane of paper, and T/S of stem at point indicated by dotted line showing how stipules flank petiole; b, side view of fused stipules clasp the stem with petiole lying in the plane of the paper, and T/S of stem showing how stipules are fused and lie opposite the petiole. 4, marginal hair line in stipules of *Eriosema*: 1, free stipules; a, hair line extending to base of stipules, 2, fused stipules showing a split down the middle; b, end of hair line; c, uneven edge showing direction of rupture. 5a, diagrammatic representation of an *Eriosema* calyx showing component parts; b, side view of an *Eriosema* flower showing the relative position of the three types of lobes: 1, keel lobe; 2, lateral lobes; 3, vexillar lobes. 6, diagrammatic representation of an *Eriosema* gynoecium. 7, *E. cordatum*, fruit cut away showing seed attachment to valves. 8, *E. cordatum*, plants showing a range of variation in length of inflorescence (5 plants collected from one population at the Scottsville Race Course, Pietermaritzburg). 9, known distribution of the *E. cordatum* complex in South Africa.

In *Eriosema* all hairs are simple. Both glandular and non-glandular hairs are represented. There are two types of glandular hairs: firstly, very short stalked globose glands (white, yellow, orange or red) that vary considerably in size among the different species; secondly, uniseriate hairs with bulbous bases. The non-glandular hairs are uniseriate and vary in colour from hyaline to white, grey, tawny or ferruginous.

Leaves. Trifoliolate leaves are more common than unifoliolate leaves. Occasional tetrafoliolate leaves occur in *E. psoraleoides*. Cotyledons are always unifoliolate. In all taxa the first two leaves of each stem are nearly always unifoliolate. Subsequent leaves may be unifoliolate or trifoliolate. Geay (1970) reported a similar situation in America. He mentioned that the 'first-formed leaves in trifoliolate species, even in strong shoots of old plants, are

always unifoliate, even up to a fifth or higher node'. The South African species commonly referred to as unifoliate are now known to include trifoliate-leaved plants as well. Since many herbarium collections are made before the fourth internode has elongated, it is often difficult to decide whether the first formed three unifoliate leaves are the basal leaves of a unifoliate or a trifoliate species. Similarly, it commonly happens that the basal leaves have abscised by the time the fourth and higher internodes have elongated. Such plants are often referred to as trifoliate-leaved plants. These so-called trifoliate-leaved species may include unifoliate-leaved plants, but less rarely so than the so-called unifoliate-leaved species including trifoliate-leaved plants. For these reasons the use of leaf structure as used by previous authors has been dropped as a key character for the delimitation of taxa in the *E. cordatum* complex.

The size, shape, vesture and texture of the leaves have been found to be useful definitive characters. However, as will be indicated later, both size, shape and vesture exhibit a remarkable variation under different environmental conditions. An appreciation of this variation alone will do much to help in the understanding of the anomalies encountered in the keys of Harvey (1862) and Burtt Davy (1932), both of whom relied heavily on the shape, foliation and vesture of leaves as diagnostic criteria.

The shapes of leaves seen in this complex have been classified according to Hickey's (1973) 'Classification of dicotyledonous leaves' (see also Dilcher, 1974). As this system is not readily available, a length-breadth ratio is sometimes provided in brackets after the description of each shape. This allows for a rapid conversion of Hickey's terms to the equivalents of any other system. All the leaf measurements given are those of mature terminal leaflets, or if there are no trifoliate leaves, then of the mature unifoliate leaf.

Petioles. Petioles are either subsessile or elongated. Most are channelled and ridged on the adaxial surface. Length has been found to be a useful character in some instances, but in others this parameter shows marked plasticity.

Stipules. Stipules are a key character in *Eriosema*. They may be free and laterally positioned in relation to the petiole, that is, if the petiole was held tightly against the stem the stipules would flank it (Fig. 3a); or they are connate and opposite the petiole, that is, would not flank the petiole if it was held tightly against the stem (Fig. 3b).

The use of the stipule as a key character requires careful observation as in some species the connate stipules are wont to split to the base, and may therefore be mistaken for a pair of free stipules. This disadvantage is readily overcome however by a careful inspection of the hair line along the margin of the stipule (Fig. 4). It can be seen that in free stipules the hair line extends uninterruptedly to the base (Fig. 4.1a) whereas in connate stipules that have split, the hair lines end abruptly (Fig. 4.2b). The split margin is also uneven (Fig. 4.2c). Connate stipules usually split as a result of the expansion of nodal tissue.

The stipules are either tightly clasped to the stem, patent, or recurved. In some taxa the stipules persist but senesce rapidly almost before the young leaflets expand, whereas in other taxa the stipules persist but remain green until almost the end of flowering. In *E. psoraleoides* the stipules are often caducous. These are valuable field characters.

Reproductive parts

Inflorescences. In all taxa the inflorescence is an axillary raceme bearing (1)–50 flowers. Flower number is too variable to be of much diagnostic significance. The length of the peduncle is useful in diagnosing *E. psoraleoides* as in this species it is always less than one third of the length of the raceme. Flower bracts are either caducous (*E. psoraleoides*) or persistent (all other spp.); shorter (*E. nutans*), or equal to (*E. cordatum*) the calyx. Bract vesture may be sericeous, pilose, pubescent or stiff patently hairy.

Flowers. The component parts of the flower vary considerably in shape, colour, pubescence, gland encrustment and dimensions. Flower colour has proved to be a useful distinguishing character. Flowers are consistently either pure yellow, or red and yellow, or pale pink with purple stripes, or red, yellow and orange, or orange and yellow. Herbarium collections of all but the yellow-flowered taxa turn purple on drying: yellow flowers retain their colouration. Flowers usually hang downwards before they open. As they open they tend to rise into the horizontal plane but return to their former position when they close.

(a) **Calyx.** All taxa have a five-lobed campanulate calyx with distinct triangular or lanceolate teeth (Fig. 5a). Three parts of the calyx are referred to in this study: calyx lobes, calyx teeth and calyx tube. The fused portion of the calyx is called the calyx tube (Fig. 5a) whereas the unfused portions are called the calyx teeth (Fig. 5b). The fused and unfused portion of each segment together is called a calyx lobe. The lobes are measured from the apex of each tooth to the base of the tube directly beneath each tooth. Other authors use the term lobe instead of tooth. Three types of calyx lobes have been distinguished.

1. **Keel lobe** (Fig. 5a.1) This lobe lies directly beneath the keel and is thus abaxial (Fig. 5.1).
2. **Lateral lobe** (Fig. 5a.2). There are two lateral lobes. These lobes are situated one on each side of the flower (Fig. 5b.2). They are always equal in length and upcurved towards the vexillar lobes.
3. **Vexillar lobe** (Fig. 5a.3). There are two vexillar lobes. These lobes are situated on the upper (adaxial) part of the flower. The vexillar lobes may be markedly connate or free and this is a useful character in some taxa.

The calyx teeth may be triangular (*E. parviflorum*) or lanceolate (*E. cordatum*); and shorter (*E. parviflorum*), or longer than, or equal to the calyx tube (*E. nutans*). The calyx lobes may be shorter than half the length of the flower (*E. psoraleoides*, *E. parviflorum* and *E. cordatum*) or equal (*E. nutans*) or longer. Vesture on the calyx ranges from shortly pubescent (*E. parviflorum*) to stiff long ferruginous-haired (*E. cordatum*).

The length, pubescence and degree of fusion of the calyx lobes; the shape and length (in relation to calyx tube) of the calyx teeth; and finally the length of the calyx lobes (in relation to the length of the flower) are all useful diagnostic criteria.

(b) **Standard.** The standard varies in colour, size, shape and structure. Hickey's (1973) classification has been used to determine shapes. Length-breadth (l/b) ratios are given as was done for leaves. Shape varies from narrow obovate (2:1) to wide obovate (1.2:1, *E. psoraleoides*), or oblong (2:1, *E. buchananii*). The apex may be rounded, emarginate or hooded.

Auricles vary in size, and range from prominent inflexed flaps (*E. buchananii*) to small slightly inflexed flaps (*E. cordatum*). The appendages of the standard are important diagnostically. These are situated on the inner surface just above the auricles (*E. cordatum*), well above auricles but less than half-way up the blade (*E. zuluense*), or high up and above the middle of the blade (*E. buchananii*). The appendages may be free (*E. buchananii*), partly connate at base (*E. parviflorum*) or connate (*E. nutans*). *E. psoraleoides* and *E. lucipetum* (anomalous population Stirtan 1340) are both characterized by the absence of any appendages.

The back of the standard is nearly always pubescent and glandular. In *E. psoraleoides* it may also be glabrate. Two unusual specimens Streyl 5048 and Vahrmeijer 1121, which have been included in *E. cordatum* also have glabrate or glabrous standards.

The colour of the standard varies but it is constant within the species under study. It is yellow in *E. cordatum*, *E. lucipetum*, *E. zuluense*, *E. nutans*, *E. parviflorum* and *E. psoraleoides*. In *E. buchananii* it is pale pink lined with purple. *E. cordatum* has a dull red outer surface with the inner surface orange or yellow and distinctly purple-veined.

A characteristic of all taxa is the presence of a semi-circular patch of intense yellow situated just above the appendages. This patch is noticeable even in the yellow flowered taxa where it tends to be a more intense yellow. It is referred to as a 'nectar guide' in this study.

(c) *Wings*. At first glance the wings appear to be uniform. Their infrequent use as a diagnostic character has probably been due to the difficulty encountered in describing them. The wing consists of a lamina which may be cultrate (*E. nutans*), cultriform (*E. cordatum*), or narrow oblong (*E. psoraleoides*). The single auricle may be straight (*E. psoraleoides*), or forward sloping (*E. nutans*). The claw is either attenuate (*E. nutans*) or strongly recurved (*E. zuluense*).

The wings may be shorter, equal to or longer than the keel blades. Colour varies from yellow, yellow with flushes of pink, to orange.

(d) *Keel blades*. The keel blades show various degrees of fusion. The shape is difficult to describe but ranges from narrow oblong narrowing towards the claw (3: 1, *E. psoraleoides*) to variously curved to almost falcate abaxially. The apex may be obtuse, falcate or rostrate. The auricle is less defined than in the wings. It may be recurved, vertical or forward sloping. The claw is attenuate. The keel blades are usually wider than the wings. The keel blades may be equal to (*E. psoraleoides*), shorter than (most species) or longer than (*E. parviflorum*) the wings. The lamina may be sparsely or densely encrusted with glands. The base line of the keel blade may be glabrous or hairy. The keel blade is generally greenish white in colour.

(e) *Androecium*. The stamens are diadelphous with the vexillar stamen free. The vexillar stamen has a knee-like thickening near the base. The thickness of this knee is usually proportional to the depth of the claw of the standard. The fused stamens are collectively referred to as the staminal sheath. The anthers form two whorls when the sheath is closed as alternate filaments are unequal in length. Anthers are uniform, dehiscing longitudinally.

(f) *Gynoecium*. The length of the gynoecium and the variation in its components are important characters.

The ovary may be stalked, subsessile or sessile. It is biovulate (rarely triovulate in *E. psoraleoides*) with two campylotropous ovules. The type and degree of vestiture on the ovary wall is a useful character. The hairs may extend less than half the length of the valves. The style is glabrous, or minutely hairy and glandular, or eglandular. It is variously thickened at, or beyond, the point of curvature. The height of curvature is a useful character and is calculated as the vertical distance from the base line of the style to the level of the stigma (Fig. 6). The erect portion of the style may be straight or incurved. The stigma is capitate, inserted.

(g) *Discoid floral nectary*. Whilst floral nectaries have been frequently reported in papilionoid legumes, particularly in the tribe Phaseoleae (Waddell & Lersten, 1974), their presence in the genus *Eriosema* is poorly documented. This is probably owing to their small size and also to the difficulties involved in the interpretation of their structure. Phillips (1951) mentioned that the ovary in *Eriosema* is 'usually surrounded by a small cupular disc'. The only other report found was Waddell *et al.*'s (1974) report of the presence of a discoid floral nectary in *Eriosema rufum* Don. There are no reports on the presence of floral nectaries in the American species (Grear, 1970). Discoid floral nectaries have been found in all the species studied in the present work.

The ontogeny of discoid floral nectaries remains obscure. Moore (1936) thought that they resembled a staminal sheath and were more closely associated with the staminal whorl than with the gynoeceum. Waddell (1968) suggested alternatively that the disc nectary was not a reduced whorl but an outgrowth of the receptacle. The solution to this puzzle of morphological interpretation will involve, as Waddell *et al.* (1974) pointed out, a careful ontogenetic study. The discoid floral nectaries in all the taxa studied here were securely adnate to the base of the staminal sheath. In view of the lack of ontogenetic evidence the discoid floral nectary has been considered in the description of species as an independent structure.

The sizes and shapes of the floral nectaries are variable. The apical margin may be wavy, erose, smooth, finely dentate or revolute. The type of margin appears to be correlated with the quantity of nectar secreted. Nectaries with irregular margins were seen, in the field, to produce more nectar at one time than the smooth margin nectaries. Frey-Wyssling (1955) has reported that the relative proportions of xylem and phloem in nectaries affects the type of secretion. Nectaries which are supplied mostly by phloem tissue tend to secrete nectar with a high sugar concentration. It is difficult to interpret the meaning of the lack of vascular tissue reported in the nectary of *Eriosema rufum* Don (Waddell *et al.*, 1974). A study is needed to correlate types of vascular tissue with nectar secretion in *Eriosema* and then to correlate the nectaries with pollination mechanisms. A useful study could be made of the structure, morphology, stomatal distribution and ontogeny of nectaries in papilionoid legumes. I am not aware that such a survey has been made for the family as a whole.

Fruits. The fruits are compressed 2-valved, 2-seeded dry dehiscent pods. The valves are obliquely beaked, oblong (2:1) to wide oblong (1, 5:1), or trapeziform. The valves are smooth and shiny inside, and usually sericeous, velutinous, pilose hairy or shortly pubescent outside. The valves dehisce along upper and lower sutures until they remain attached

only at the base. Most of the South African species dehisce with an explosive action. This may be due to an environmental influence as pods of the same species have been seen to dehisce very slowly during cloudy overcast conditions. The separated valves coil very tightly once the seed has been shed.

Seeds. Mature seeds are smooth, dull or shiny, compressed, transverse or oblique. Shape may be oblong, reniform or somewhat mango-shaped. Seed colour varies from black or deep purple to chestnut brown to khaki, with or without speckles and mottles. Polymorphic seeds are commonly produced in a species but although both types are never found on the same plant they may occur in the same population. In *E. parviflorum* the black seeds are thicker and narrower than the speckled khaki seeds (see under Insect infestation).

The hilum of the *Eriosema* seed is linear and extends almost the whole length of the seed. The sub-horizontal funicle is attached at the inner extremity. The thick bilabiate flange flanking the hilum is referred to as a strophiole (after Grear, 1970). The attachment of the seed of the valve wall can be seen in Fig. 7.

Seeds swell to almost double their size when they imbibe water. This effect is also seen in the unripe pod. When the pod is green and fully developed the two seeds almost fill it, but as the pod blackens and dries out the seeds shrink to almost half their previous size.

ECOLOGY

Throughout this study field observations have been aimed primarily at assessing the range of variation within the taxa under study. If the field observer repeatedly meets a particular phenomenon, or range of variation, in the individuals or populations under study and this is frequently associated with a particular set of environmental or local habitat conditions, there is some justification for associating these where either one, or the other, is encountered in new field situations. Therefore a field observer experienced in the study of a particular group of plants, should be able to draw upon his experience when meeting new plants of the same genus in new localities. Under these conditions his intuitive assessment of variation in relation to general habitat conditions should be reasonably accurate, despite his inability to relate a particular feature of variation to a particular environmental factor.

If, in the consideration of variation within the species in this study, an environmental factor, or plexus of factors, are suggested as being related to some particular morphological form, or feature of it, this is the outcome of field observation and is regarded as a reference point to be kept under consideration, rather than as a factual statement of cause and effect.

This section collates various field observations that have been useful in understanding the species under study. Selected examples of infraspecific variation are presented in order to provide as broad a picture of the species as possible. Fortunately most of the examples presented are indicative of the types of variation, and phenomena, to be found in the whole *E. cordatum* complex. Where relevant more detailed accounts are given under each species.

Field observations

Plants growing in full sun tended to be shorter and more compact than plants of the same species grow-

ing under different intensities of shade. Similarly plants that grew in burnt veld had a more stunted form than did plants of the same species which grew in adjacent unburnt veld. These phenomena, which apply to all species in the *E. cordatum* complex, were fully discussed in a previous paper (Stirton, 1977).

E. cordatum was observed to exhibit a markedly greater variability than any other species in the complex. Plants that grew in the same population showed a variation in the size, shape and foliolation of the leaves, degree of compactness of flowers on the inflorescence, length and thickness of the peduncle, shape and senescence of the flower bract and finally the size of the standard. Fig. 8 shows the variation which can occur in the length of the inflorescence within the same population.

It was found that plants of *E. cordatum* that grew in tall grass had bigger leaves, longer internodes, shorter inflorescences and smaller standards, than those plants that grew in short grass in more open areas. In other populations the peduncle was very long in tall grass and short in short grass.

Allsopp (1947) wrote that plants of *E. cordatum* become suppressed if the veld remains unburned, or is heavily grazed and trampled. This information appears to have been based only on the inspection of field sites.

The combined influence of wind and sun appear to affect *Eriosema* plants. In prolonged hot windy weather these plants tended to die back from the growing points and to shed their basal leaves. This observation is important since the first dichotomy of the available keys differentiates between unifoliate and trifoliate leaves. It is now known that many species, *E. cordatum* in particular, produce their first trifoliate leaf at the fifth or higher node. Such a plant, if collected before the trifoliate leaves had been produced, would be difficult to key out. Similarly for a trifoliate-leaved plant that had already shed its basal leaves. The loss of unifoliate leaves by a predominantly trifoliate-leaved plant may of course be due to natural ageing.

Hot windy days have also been observed to wither flowers. Two populations of *E. cordatum* were observed to have failed to set seed for an entire season because the flowers withered just as the corollas emerged from the calyx.

Insect infestation

Insect larvae, particularly Agromyzidae, cause extensive damage to various plant parts. Eleven different types of larvae have been collected and await identification and I am indebted to Dr B. R. Stuckenberg of the Natal Museum for his advice. He informed me that most species of Agromyzid flies lay their eggs in particular plants and are host specific to those plants. The observation that some larvae of these insects are found only in certain species has been a useful field guide for the field identification of species. These studies when pursued promise to be most rewarding. The different Agromyzid larvae form distinctive patterns (mines) beneath the cuticle or epidermis. Such patterns are often most noticeable on herbarium specimens.

Further studies are also needed on the insects which cause extensive damage to seeds. In *E. parviflorum* both laboratory and field observations revealed that the production of polymorphic seeds was closely associated with the infestation of insects in fruit pods. Pods with black seeds were rarely affected, whereas in pods with speckled, greenish

yellow seeds, the seeds rarely reached maturity because of heavy insect damage. These seeds should be analysed comparatively for chemicals that inhibit predation.

GEOGRAPHICAL DISTRIBUTION

The geographical distribution maps presented are based mainly on the author's field collections and available herbarium material. This commonly used approach to the compilation of distribution maps has certain pitfalls that should be recognized. Firstly the distribution map is not necessarily a reflection of the taxon's extant distribution. It stands to reason that the compilation of a distribution map is an act based on an a priori hypothesis that the map will provide the basis for some deductive argument. If this is so, then a map compiled from herbarium collections spanning a century or more is indeed a shaky base for any type of interpretation. This awareness of a space-time relationship is seldom considered in the compilation and interpretation of distribution maps. The use of unchecked specimen citations gathered from the literature hardly needs any comment. The second pitfall is that a map compiled from all the available herbarium material is open to severe criticism if, as White (1971) so testily states, its interpretation concerns unwarranted speculations as to its inclusive variation. The reason is that the known complexity of genetic systems, including hybridization, polyploidy and apomixis, is such that any particular expression of a phenotypic character could be theoretically possible over any interval of time and at any particular point of a taxon's range. Such expression may have little or no significance in an understanding of the taxon's origin or distribution pattern. The chances of this situation occurring are greater the older are the specimens used. The third pitfall concerns the frequent attempts by botanists to discover variables of ecological significance by a reference to distribution maps. Although not known as such, this phytocartogeographic approach has an equivalent in

the zoocartogeographic approach of zoologists. An example of the problem and the confusion that may develop is shown in the critical assessment by Stuckenberg (1969) and Van Dijk (1971) of Poynton's (1964a, 1964b) faunal study of amphibia in southern Africa. The final pitfall is obvious and common to most approaches. It concerns the correct delimitation of taxa. Even one incorrectly named specimen in a distribution map can lead to incorrect interpretations.

The known distributional ranges of all the species studied in this complex is given in Fig. 9. This complex occurs mainly in the Transvaal, Swaziland, Natal and the eastern Cape Province. Very few collections are known from Lesotho, Botswana and the Orange Free State. No representatives of the complex occur in South West Africa/Namibia or the western and northern Cape Province.

Eriosema cordatum and *E. psoraleoides*, have the most widespread distribution of the group in southern Africa, whereas *E. nutans* is less widely dispersed. The only really restricted distributions are those of *E. buchananii*, *E. zuluense*, and *E. lucipetum*. Four species of the complex extend beyond southern Africa. These are *E. buchananii*, *E. nutans*, *E. parviflorum* and *E. psoraleoides*.

TAXONOMY

The descriptions of *Eriosema* species that follow are based on the author's examination of herbarium material and of populations in the field in South Africa.

A selected citation of representative specimens of each species recognized in this study is given in the enumeration of species. This was prepared by the selection of a single voucher specimen from amongst all specimens studied to serve as a record of each quarter degree square through which the taxon was naturally distributed.

KEY TO SPECIES

Stipules connate:

Calyx teeth triangular, shorter (rarely equal to) than calyx tube; pubescent or tomentose, rarely with few scattered longer hairs; appendage of standard situated well above auricles; flowers yellow 1. *E. zuluense*

Calyx teeth lanceolate, always longer than calyx tube, stiffly shaggy or pilose; appendage of standard situated low down or just above auricles or if higher then extending to auricles; flowers red and yellow ... 2. *E. cordatum*

Stipules free:

Perennial herbs; calyx teeth lanceolate, longer than calyx tube 3. *E. lucipetum*

Shrubs or suffrutices; calyx teeth shortly triangular, mostly equal to or less than calyx tube:

Plants erect shrubs; stipules minute < 5 mm long; appendages absent on standard; peduncle of inflorescence < 1/2 length of inflorescence 4. *E. psoraleoides*

Plants ascending, decumbent or erect suffrutices; stipules > 5 mm long; appendages present on standard; peduncle of inflorescence > 1/2 length of inflorescence:

Stipules 10–16 mm long, 2.5–4.0 mm wide, oblong-lanceolate, base narrower than middle; flowers pale pink lined with purple; appendages of standard high up above middle; free, shallow ridged, half moon shaped, vertical to axis of standard 5. *E. buchananii*

Stipules 5–8 (10) mm long, 1–2 mm wide, linear lanceolate or triangular, base wider than middle; flowers yellow; appendages of standard situated low down just above the auricles, connate, upcurled flaps, horizontal to axis of standard:

Stipules mostly erect, clasping stem; petiole 3.1–7.0 mm long; leaf rachis (7) 8–11 (12) mm long; flowers 7.5–10.0 mm long; flower bracts lanceolate; calyx (3.0) 3.5–4.3 (4.5) mm long; standard oblong; wings longer than keel blades. Leaves not photonastic. (Transvaal.) 6. *E. nutans*

Stipules recurved and spreading when old; petiole 1.0–2.2 (3.0) mm long; leaf rachis 2–6 mm long; flowers 5–6 mm long, flower bracts shortly triangular; calyx 2–3 mm long; standard wide obovate; wings shorter than keel blades. Leaves photonastic. (Natal, one record from N. E. Transvaal) 7. *E. parviflorum*

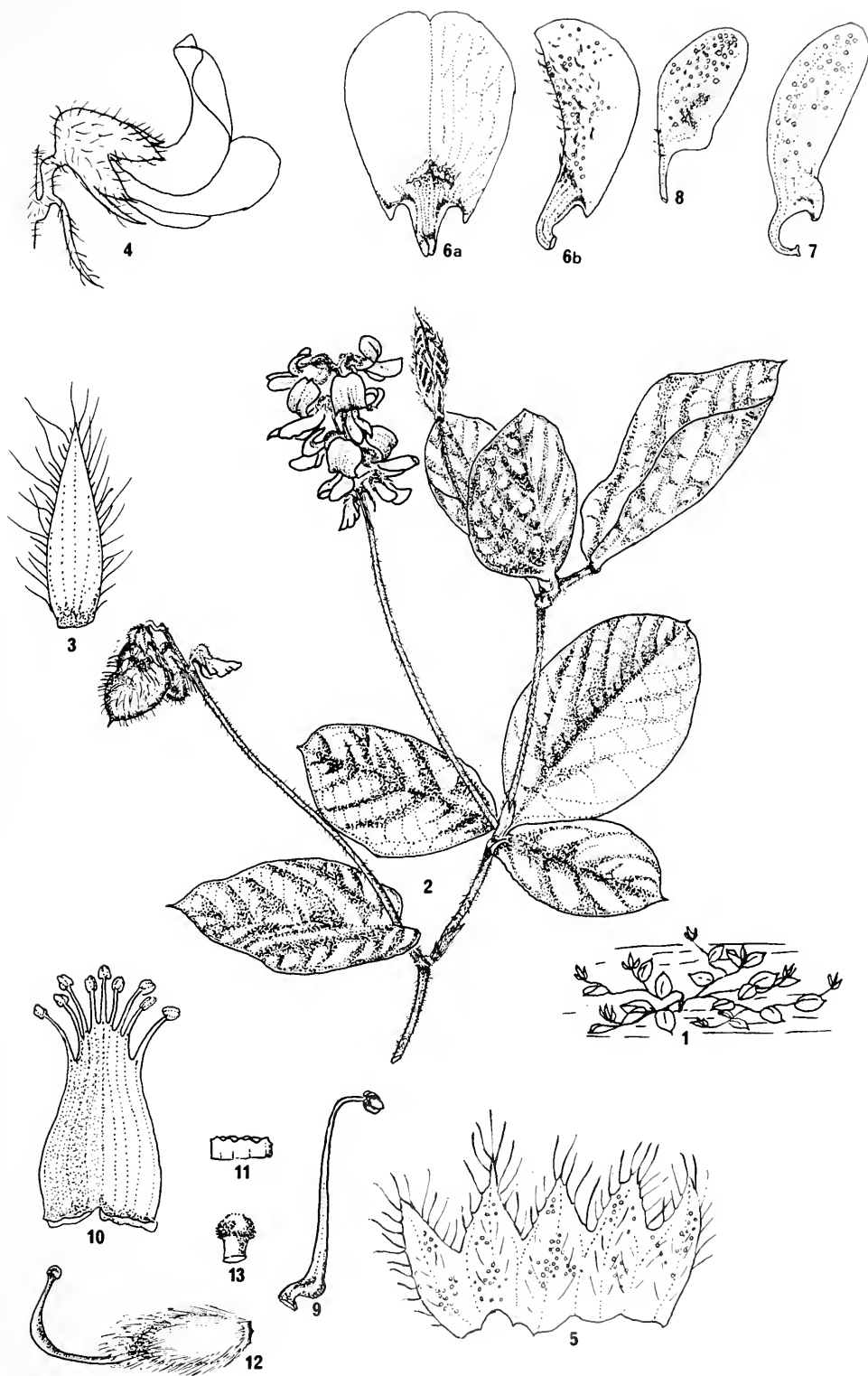


FIG. 10. — *Eriosema zuluense*. 1, habit; 2, stem with fruits and flowers, $\times 1,2$; 3, flower bract, $\times 9$; 4, flower, $\times 3,8$; 5, calyx opened out, $\times 9$; 6a, standard opened out, $\times 4,6$; 6b, standard closed $\times 4,6$; 7, wing, $\times 4,6$; 8, keel, $\times 4,6$; 9, vexillar stamen, $\times 6,4$; 10, staminal sheath, $\times 6,4$; 11, discoid floral nectary, $\times 18$; 12, gynoeceium, $\times 6,4$; 13, stigma, $\times 40$.

1. *Eriosema zuluense* C. H. Stirton, sp. nov., *E. cordato* E. Mey. affinis, sed dentibus calycinis triangularibus, tubo brevioribus (raro eum aequantibus), floribus luteis, appendiculo interno vexillari manifeste supra auriculos sito distinctam.

Herbae perennes, prostrati vel repentes vel decumbentes, 10–12 cm altae. *Folia* 1-foliolata, raro infima 3-foliolata, 4,0–5,5 cm longa et lata, late ovata, apice obtusa cum apiculo, basi cordata, utrinque praesertim secus venas sparse sericea, parce glandulosa, margine revoluta. *Stipulae* connatae. *Racemi* axillares, 20–30-flori, folia excedentes. *Flores* lutei, 10–12 mm longi, bractis dimidio longitudinis florum, cito caducis. *Calycis lobi* aequilongi, dentibus triangularibus, tubo brevioribus, molliter pubescentibus. *Vexillum* alis aequilongum, omnibus carinam valde glandulosam excedentibus. *Fructus* 12×10 mm, oblongus, prominentes rostratus, sericeus, tenuiter pubescens.

TYPE.—Natal, 2831 (Nkandla): Ntambanana (—DA), *Acocks* 12980 (K, holo.!: PRE).

Perennial herb, 10–12 cm tall, flowering in spring. *Stems* trailing, prostrate or decumbent, finely pubescent with reflexed yellowish hairs. *Leaves* 1-foliolate, rarely the lowest leaves 3-foliolate, 4,0–5,5 cm long and wide, broadly ovate, apex blunt with a point, base cordate, both sides sparingly sericeous especially along the veins, sparsely glandular, margin revolute. *Stipules* 5–7 (10 mm long, lanceolate, connate but occasionally splitting when old, sericeous. *Petioles* 2–4 mm long. *Racemes* axillary, (10) 20–30-flowered, exceeding the foliage, peduncle 5–6 cm long. *Flowers* yellow, 10–12 mm long, bracts ± half the length of the flower, rapidly caducous. *Calyx* 4 mm long, lobes equal in length; teeth triangular, shorter than (rarely equalling) the tube, softly pubescent and sparingly glandular. *Standard* ± 12 mm long, 5 mm wide, oblong, equal in length to the wing petals but always exceeding the keel; appendages slightly fused, free from auricles. *Wings* 12 mm long, 3 mm wide, oblong, auriculate, pouched, longer than the keel. *Keel* 8 mm long, 3 mm wide, strongly glandular, sparingly pubescent along base, pocket present. *Staminal sheath* 7 mm long, free stamen geniculate; anthers uniform, alternately long-basifixed and short-medifixed. *Gynoeceum* 7 mm long; ovary 4 mm long with 1 mm long gynophore, densely sericeous, curvature of style 3 mm high; stigma capitate. *Nectary* present, high as gynophore; margin erose. *Fruit* 12 mm long, 10 mm wide, oblong with a prominent 3 mm long beak, sericeous and finely pubescent. Seed not seen. Fig. 10.

Eriosema zuluense is endemic to Zululand and stretches from Josini Dam and Hluhluwe in the north to Mhlabatini, Hlabisa, Melmoth, Eshowe and Ngye Forest in the south (Fig. 11).

NATAL.—2732 (Ubombo): Hilltops on main road to Josini (—CA), *Pooley* 276; 6 km from Ubombo (—CA), *Stirton* 505; Ubombo Mountain Summit (—CA), *Venter* 1768, 4308. 2831 (Nkandla): Mhlabatini (—AB), *Gerstner* 4185, 4232; Nkweleni (—BA), *Lawn* 1548; 8 km south of Hlabisa (—BB), *Codd* 2004 and *Acocks* 13067; 25 km south-east of Melmoth (—CB), *Codd* 1838; Eshowe (—CD), *Lawn* 1164; between Nkweleni and Eshowe (—DA), *Stirton* 426; 9 km west of Ntambanana (—DA), *Codd* 1885; 8 km north-west of Ntambanana (—DA), *Acocks* 12980; Ngye Forest Reserve (—DD), *Venter* 406. 2832 (Mtubatuba): Hluhluwe Game Reserve (—AA), *Ward* 1548. Without precise locality: *Gerstner* 4656. This is a mixed sheet which also has a specimen of *E. cordatum*.

This species is somewhat variable and additional collecting is needed. It is best exemplified by *Acocks* 12980, *Codd* 1885, *Codd* 2004, *Ward* 13067 and *Ward* 1548. *E. zuluense* is characterized by its

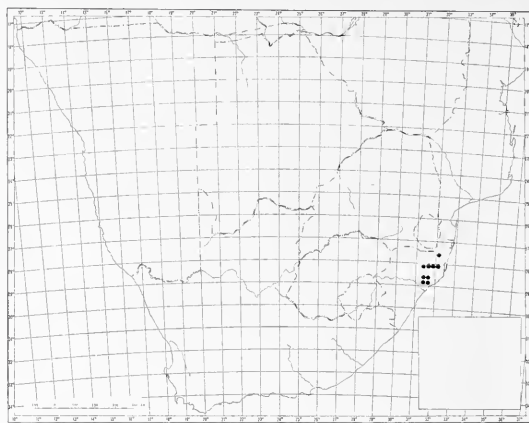


FIG. 11. — Known distribution of *Eriosema zuluense* in South Africa.

vesture, habit, branching and its triangular calyx teeth shorter than the calyx tube. *Acocks* 13067 is unusual in that the stipules are rapidly caducous and the leaflets narrower.

The plants grow in dense grassland on rocky hillsides, particularly dolerite outcrops, between 300–400 m. Flowering occurs between October and December.

The specific epithet *zuluense* refers to the region throughout which they are distributed.

2. *Eriosema cordatum* E. Mey., Comm. 128 (1836); Meisn. in J. Bot., Lond. 2: 80 (1843); Harv. in Fl. Cap. 2: 259 (1862); Burt Davy, Fl. Transv. 2: 413 (1932); Verdc. in Kew Bull. 25: 118 (1971); Ross, Fl. Natal, 208 (1972). Type: Natal, between Gekau and Basche, in grassland (V, b, 22) *Drège* s.n. (PRE; K, iso.).

E. guenzii Sond. in Linnaea 23:34 (1840); Drège, Zwei Pfl. Doc. 145 (1843); A. Dietr., Fl. universalis II: 187 (1861), icon. Syntypes: South Africa, Natal, Port Natal, *Guenzius* 27, 634. (PRE; K, isosyn.).

E. cordatum E. Mey. var. *guenzii* (Sond.) Harv. in Fl. Cap. 2: 259 (1862); Burt Davy, Fl. Transv., 2: 413 (1932); Verdc. in Kew Bull. 25: 118 (1971).

Perennial herb 5–60 cm tall with 1–20 stems from short stylopodium of underground rootstock. *Woody rootstock* vertical, daucate, up to 50 cm deep. *Stems* prostrate, decumbent to semi-erect; terete or trigonous; variously ribbed; vesture hispid, hirsute, velutinous or pilose; hairs red, white or tawny; if glandular then orange, red or yellow glanded. *Leaves* unifoliolate, or trifoliolate with basal leaves unifoliolate; *stipules* (4,0) 5,0–15 (23) mm long, 3–8 (12) mm wide; narrow ovate (2:1) to lanceolate (3:1), often falcate; semi-connate, either splitting or tightly clasping stem; glabrescent or hairy. *Petiole* (2) 4–7 (20) mm long. *Leaflets* 6–10 (14) cm long, (2,5) 3,0–5,0 (9,2) cm wide, laterals smaller; base cordate or obtuse; apex obtuse, rounded or acute; terminal leaflet symmetrical, ovate (1,5:1) to very wide ovate (1:1 or less), elliptic (2:1) to suborbiculate (1, 2:1), laterals asymmetrical, oblique, oblong, (2:1) to narrow oblong (3:1), to ovate (1,5:1) to narrow ovate (2:1); vesture strigose, sericeous, hirsute, pilose or velutinous, erect or appressed. *Young leaflets* either densely glandular or eglandular, with red foxy or white hairs. *Petioles* 2–4 mm long. *Rachis* (9) 10–15 (23) mm long, rarely with two persistent acrorachial stipels. *Racemes* 3–27

flowered; *peduncle* 5–12 (21) cm long; *rachis* 2–5 cm long; *flowers* 8–10 (13) mm long, 3–5 mm wide; reflexed vertical or with apex recurved until touching calyx; red and yellow, or red, yellow and orange; bracts lanceolate, persistent or deciduous. *Calyx* (3,0) 4,0–6,0 (7,8) mm long, half length of flower, teeth equal or unequal, longer than tube; lanceolate; stiffly shaggy or pilose; glabrous or finely hairy inside; glandular; tube (1,5) 2,0–4,5 (5,0) mm long; vexillar lobes (3,8) 4,0–6,0 (7,8) mm long; lateral lobes (3,0) 4,0–5,5 (6,5) mm long; keel lobe (3,8) 4,0–6,0 (7,5) mm long often thinner or incrassated. *Standard* (8,0) 10,0–11,0 (12,3) mm long; 4,4–7,0 (9,0) mm wide; oblanceolate (3,1) to wide obovate (1,2:1), narrowed towards auricles; apex obtuse, retuse or emarginate; usually densely white pubescent and glandular on back, but occasionally glabrescent; claw 2–3 mm long; auricles inflexed, prominent; appendages bifurcate, between or just above auricles, either low ridges or large upcurled flaps, (3,2) 3,8–4,0 (4,8) mm from base of claw. *Wings* (7,8) 9,0–11,5 mm long, 2,1–3,5 (4,0) mm wide at maximum; longer than keel blades; claw 1,2–2,0 mm long; auricles 1,2–2,0 mm high. *Keel blades* (6,2) 6,8–8,0 (8,5) mm long, 3,0–4,6 mm wide at maximum; yellow, white or orange glanded; claw 1,2–2,8 mm long; auricles 1,2–2,8 mm high. *Staminal sheath* 6,0–7,2 mm long, 2,5–4,0 mm wide at maximum, vexillar stamen 5,0–7,2 mm long. *Gynoecium* (5,0) 6,5–7,0 (7,5) mm long, ovary 2,5–4,0 mm long; with

stalk 0,3–1,0 mm long, hairs extending to half length of pistil; style incrassated at or above point of flexure, curvature 2–3 mm high; stigma level with anthers, capitate. *Discoid floral nectary* smooth slightly rippled or erose irregular. *Fruits* (11) 15–16 (17) mm long, 9–11 mm wide, wide oblong (1,5:1), strongly compressed; beak straight, downward or upward pointing; with scattered golden brown hairs mostly patent but appressed on margins and often glabrate on sides, apex oblique. *Seeds* 3,0–5,2 mm long, 1,7–2,4 mm wide, chestnut brown or khaki, with or without speckles, hilum white or brown. (See Fig. 7, Stirton, 1978.)

Eriosema cordatum is common and widespread in Swaziland and eastern parts of South Africa. It occurs less commonly in Zimbabwe, Mozambique and Lesotho.

This difficult species has long been the dumping ground for many specimens of *Eriosema* in South African herbaria. The two factors which have probably contributed most to this confusion are the occurrence of marked phenotypic plasticity within the taxon and the occurrence of extensive hybridization (Stirton, 1981) of this species with other species.

E. cordatum remains the most heterogenous group in the *E. cordatum* complex and includes within its range of variation the previous varieties *cordatum* and *guenzii*. This taxon is the most widespread *Eriosema* in southern Africa (Fig. 12). Preliminary

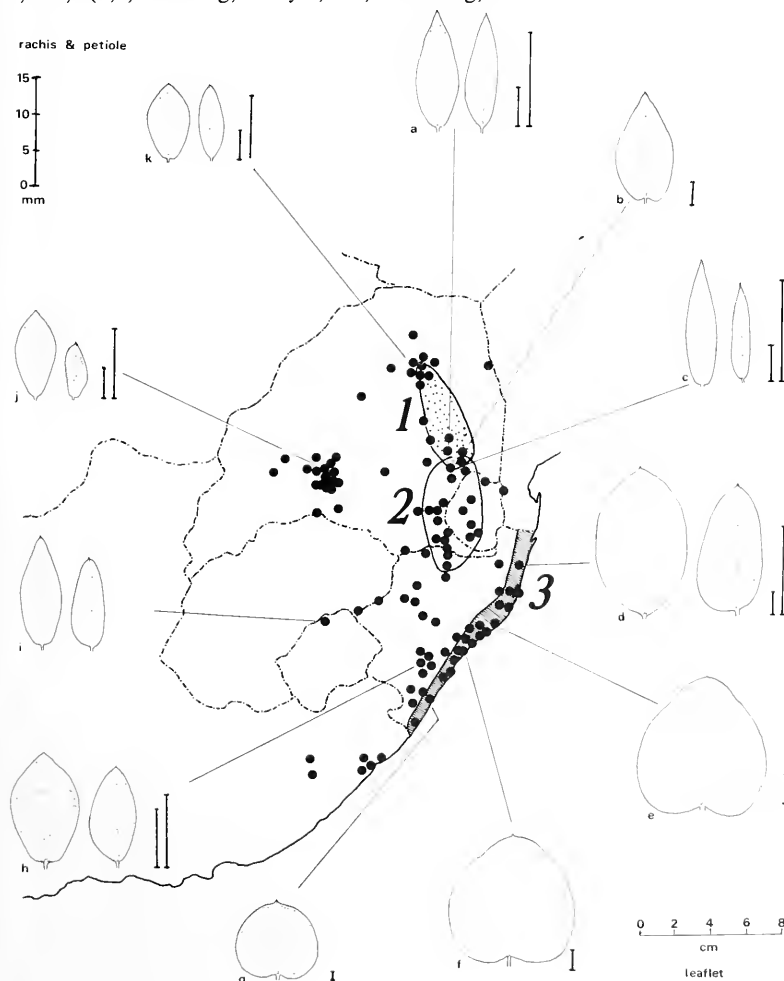


FIG. 12. — *Eriosema cordatum*. Pictorialized distribution map showing variation in leaflet shape and size, length of petiole and length of rachis. a, Galpin 1031; b, Stirton 1468; c, Stirton 1462; d, Strey 5048; e, Stirton 1620; f, Baijnath 419; g, Weeks s.n.; h, Huntley 90; i, Schelpe 1755; j, Mogg 15756; k, Scheepers 487. Where two leaflets are shown, the first is the terminal leaflet of a trifoliolate leaf and the second leaflet is one of the laterals of the same leaf. If single leaves are shown, only unifoliolate leaves occur. The left hand bar refers to length of petiole and the right hand bar refers to length of leaf rachis. Area 1, area in which unifoliolate leaved plants are likely to occur in the Transvaal; 2, area where erect plants are likely to occur; 3, area where unifoliolate cordate leaved plants grow in Natal.

fieldwork has enabled me to outline some of its complex variation. Fig. 12 is a pictorialized distribution map showing variation in leaf shape and size, relative lengths of leaf petiole and leaf rachis, stem vesture and shape of calyx lobes (Fig. 13). The areas 1–3 shown in Figs 12 & 13 are merely the known ranges of certain types of variation and do not necessarily include all the collections found within them.

Plants tended to be decumbent and predominantly unifoliate along the coastal areas (3). There was a general increase in size of the leaves from south to north. Coastal plants growing south of Port Edward were both unifoliate and trifoliate. In the Mpangazi area in northern Zululand there were a few collections which were notable for their larger flowered and sparsely haired, unifoliate condition. This area requires further investigation. Inland from the Natal coast plants became smaller and predominantly trifoliate. More stems were produced. Area 2 is an approximation of the area in which erect trifoliate leaved plants can be expected to occur [for example, *Stirton* 1462 (Fig. 14)]. Area 1 is the range of small semi-erect unifoliate leaved plants which differed from the coastal unifoliate-leaved plants in their pubescence, leaf shape and habit. These plants, for example *Stirton* 1465 & 1468 were restricted to the high altitude areas of the

eastern Transvaal. They appeared to have a close affinity to *E. gunniae* C. H. Stirton. Although included here, their identity remains open. They warrant further investigation.

Transvaal plants were predominantly decumbent, trifoliate, and small-leaved. Leaflet apices were more acute than in the Natal populations. Lateral leaflets were narrower, more asymmetrical and more oblique than lateral leaflets of Natal plants. As exceptions occurred randomly throughout the area no safe conclusions could be drawn from this data.

Stem vesture was too variable to be reliable but, considered as a whole, it was noted that the majority of plants had either tawny or ferruginous, upward or downward pointing hairs. This was a feature which, considered with the presence of a daucate rootstock, connate stipules (invariably splitting), strongly reflexed red and yellow flowers, stiff haired calyx and flower bract, and with the wing greatly exceeding the rostrate keel, could be used to separate this species from all other *Eriosemas* in southern Africa.

The morphological diversity of this species has been discussed in some detail elsewhere (Stirton, 1981) and in the section on Ecology. In summary it may be said that no useful purpose will be served at present if it is divided into a number of sub-groups.

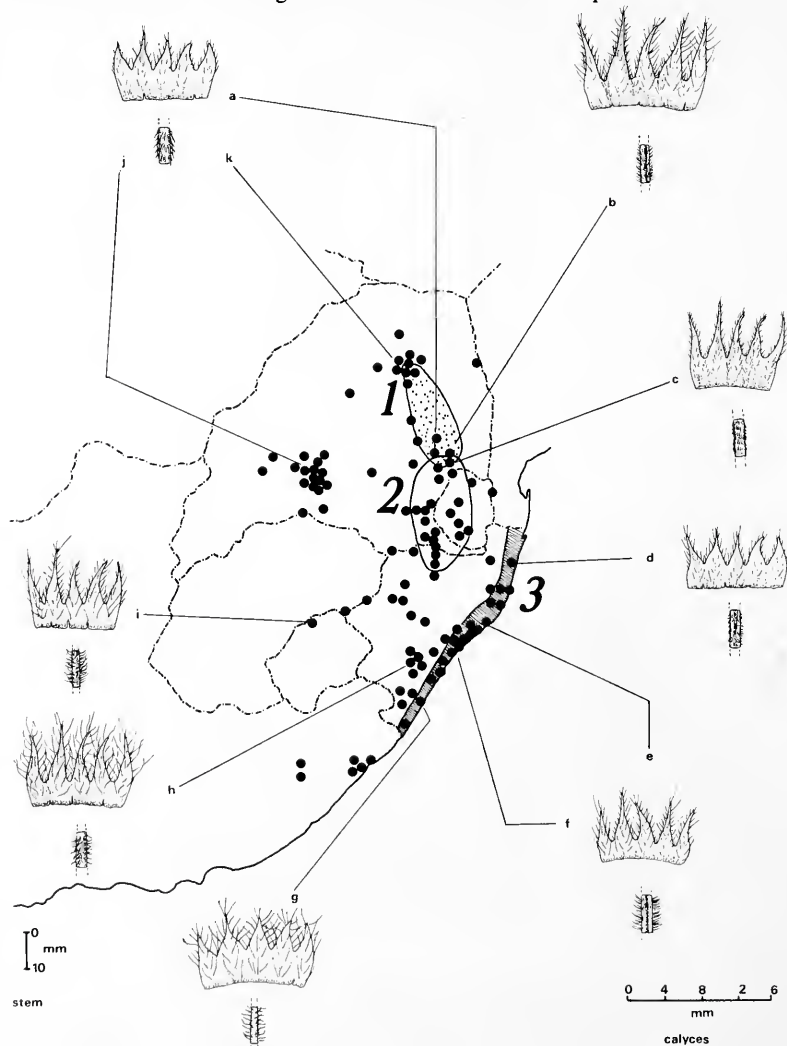


FIG. 13. — *Eriosema cordatum*. Pictorialized distribution map showing variation in shape and size of calyx, and stem pubescence. The specimens illustrated and areas demarcated are as indicated for Fig. 12.



FIG. 14.—*Eriosema cordatum*. Erect plant growing along roadside between Mbabane and Malkerns Agricultural Research Station.

If it is recognized that the species is polymorphic and if future field studies are aimed at understanding patterns within the variation encountered, much will have been done towards understanding the complex as a whole.

TRANSVAAL.—2329 (Pietersburg): Louis Trichardt (—BB), Breyer 24203; Pigeon Hole (—CD), McCallum PRE 32658; Woodbush (—DB), Jenkins PRE 32656; Haenertsburg (—DD), Stirton 1424. 2330 (Tzaneen): Westfalia Railway Siding (—CA), Stirton 1429; Modjadjies (—CB), Rogers 18019; New Agatha (—CC), McCallum s.n. 2331 (Phalaborwa): Letaba (—DA), Swierstra 4384. 2428 (Nylstroom): Palala (—BC), Breyer PRE 18124. 2430 (Pilgrims Rest): The Downs (—AA), Moss & Rogers 252, 412, 850. 2431 (Acornhoek): 9 km from Bushbuckridge to Nelspruit (—CC), Stirton 1453. 2526 (Zeerust): Koster (—DD), Burt Davy 7178. 2527 (Rustenburg): Rustenburg Nature Reserve (—CA), Jacobsen 1626; Bokfontein (—DB), Jenkins 7536; Masgaliesburg (—DC), Story & Innes 1397; Uitkomst (—DD), Coetzee 466. 2528 (Pretoria): Groenkloof (—CA), Barker 10096; Irene (—CC), Smith 5155. 2529 (Witbank): Loskop Dam (—AD), Theron 2111. 2530 (Lydenburg): Lydenburg (—AB), Wilms 5856; 35 km from Nelspruit to Sabie (—BB), Stirton 1478; Lowveld Botanic Garden (—BD), Stirton 1453; Waterval Onder (—CB), Young 26495; 15.8 km from Nelspruit to Kaapsche Hoop (—DB), Grobbelaar 847; Cyntha Letty Nature Reserve (—DD), Muller 2254. 2531 (Komatiport): White River (—AC), Gillett 1036; 12.3 km from Nelspruit to Barberton (—CC), Stirton 1462; Barberton (—CC) Williams 7645. 2627 (Potchefstroom): Krugersdorp (—BB), Cowgill s.n. J 33026; Losberg (—CB), Theron 924; Sterkfontein Caves (—DD), Mogg 35301. 2628 (Johannesburg): Robertsham (—AA), Stirton 1300; Modder East (—AB), Louw 862; 11.3 km south of Heidelberg (—CB), Acocks 20854. 2630 (Carolina): Redhill near Oshoek (—BB), Stirton 1311; Mavriestad (—CA), Pott 5074; Athole Pasture Research Station (—CB), Norval 68; 29 km from Lothair to Amsterdam (—DA), Stirton 1352; Piet Retief (—DD), Collins 13200. 2729 (Volkstrust): Volksrust (—BD), Mogg 7499. 2730 (Vryheid): Mooihoek (—BA), Devenish 70; 20 km from Paulpietersburg to Piet Retief (—BB), Stirton 1314; Wakkerstroom (—AC), Beeton 243.

SWAZILAND.—2531 (Komatiport): Devils Bridge (—DC), Compton 31722. 2631 (Mbabane): Bremersdorp (—AD), Bolus 11850; Malkerns (—CA), Compton 26164; Kubuta (—CD), Compton 32420. 2731 (Louwsburg): Goedegun (—AA), Compton 32409.

NATAL.—1730 (Vryheid): Farms Tweekloof and Altemoos (—AD), Thode A 185; Paulpietersburg (—BD), Stirton 1324; 18 km from Vryheid to Paulpietersburg (—DB), Stirton 1322; Vryheid (—DD), Stirton 1332. 2732 (Umbombo): Pongola Poort (—CA), Stirton 489; Mpangazi (—DA), Strey 5048. 2828 (Bethlehem): Mahai Valley (—DB), Schelpe 1755. 2829 (Harrismith): near Van Reenens Pass (—AD), Schweikerd 909; Elandslaagte (—BD), Shirley NU 32891. 2830 (Dundee): Dundee (—AA), Shirley 246; Buyahlanga Mountain (—AC), Stirton 1362; Tugela Ferry (—CD), Stirton 1330; 12 km from Greytown to Dundee (—DC), Grobbelaar 1630. 2831 (Nkandha): Eshowe (—CD), Lawn 1213; Ngoye Mountain (—DC),

Stirton 472; Mtunzini (—DD), Stirton 414. 2832 (Mtubatuba): Hluhluwe Game Reserve (—AA), Hutchins 599; Charters Creek area (—AB), Ward 2839; Hlabisa (—AC), Harrison 252; Dukuduku Forest (—AD), Hutchins 68; eastern shores of Lake St Lucia (—CC), Taylor 97; Enseleni Nature Reserve (—CC), Venter 6501. 2930 (Pietermaritzburg): Estcourt Pasture Research Station (—AB), Acocks 9868; Noodsburg (—BD), Hilliard 1220; Pietermaritzburg (—CB), Stirton 1235; Effingham (—CC), Oliver 558; Baynesfield (—CB), Stirton 702; Inanda (—DB), Wood 272; Chelmsford Park (—DD), Hilliard 1845. 2931 (Stanger): Thring's Post (—AA), Moll 2248; Tugela Bridge (—AB), Stirton 1268; Umhlali (—AC), Acocks 10331; Sheffield Beach (—AD), Grobbelaar 1641; Tongaat Beach (—BA), Stirton 388; Tugela Beach (—BB), Johnson 382. 3030 (Port Shepstone): near Ixopo (—AA), Hilliard 1771; Nhlavini Store (—AB), Stirton 1224; Port Shepstone (—AC), Weeks 51; Umzintlo (—BC), Bainath 419; Greenhart turnoff (—CD), Stirton 1403.

LESOTHO.—2828 (Bethlehem): Leribe (—CC), Dieterlen 221, 6845. 2927 (Maseru): Masoeling (—CB), Jacot Guillarmod 1580.

TRANSKEI.—3127 (Lady Frere): near Engcobo (—DB), Flanagan 2819; between Nuamkwe and Engcobo (—DD), Bolus 8894. 3129 (Port St. Johns): Libode (—CA), Schonland 3890; Coffee Bay (—CC), Tyson 20; Port St Johns (—DA), Baker 14164.

Vernacular names for this species include: Uqontsi (Bryant, 1909), Zulu; Leshetla — soft bone, Lesapo le letsehali — the female bone, and Setloli se sehola — the big jumper (Phillips, 1917; Jacot Guillarmod, 1971), Sesotho. Both Zulus and Sesothos are reported to use this plant for medicinal purposes. Bryant (1909) has an interesting chapter on impotency and barrenness. He wrote: 'With all primitive peoples, all that pertains to the sexual functions, involving as it does the propagation of the species and the preservation of the tribe, is a matter of paramount importance. Impotency on either side is with them more than a disgrace, it is a calamity. Should the male organs fail altogether to produce the seminal fluid, the roots of the impindisa (*Rubia cordifolia*) are boiled and drunk at bedtime, resulting in an early emission. A hot milk infusion of the roots of the Uqontsi (*Eriosema cordatum* and *E. salignum*) herb has a similar effect'.

Both Phillips (1917) and Jacot Guillarmod (1971) reported that the Sesotho mixed the Leshetla with other plants and used this as a medicine to stimulate bulls in spring. Phillips (1917) noted further that *E. cordatum* E. Mey. is less powerful a stimulant than *E. salignum* E. Mey.

Eriosema cordatum is a plant of diverse habitats and is quick to colonize disturbed habitats; areas where it readily hybridizes with other species (Stirton, 1981). Flowering occurs throughout the summer months.

3. *Eriosema lucipetum* C. H. Stirton, sp. nov., *E. cordato* E. Mey. affinis stipulis liveris et floribus luteis diversa.

Herbae perennes aut 1-foliolata erectae aut 3-foliolatae decumbentes 10–30 cm altae, prope basin ramosae. *Foliola* 8.5–11.0 cm longa, 4.5–7.0 cm lata, lateralia minima, basi cordata, apice acuta, terminalia et 1-foliolata symmetrica, anguste usque late ovata, lateralia minima, obliqua, strigosa vel sericea, pagina inferiore opaca vel nitida, glandulis pallide flavis vel rubris obsita. *Stipulae* liberae, amplexantes. *Flores* lutei, raro rosei et lutei, bracteis caducis, florum dimidio longioribus. *Calycis lobi* aequales, dentibus triangularibus vel lanceolatis tubo longioribus ferrugineis vel sparse pubescentibus. *Vexillum* et *alae* carina longiores. *Fructus* 15–17 mm longus, 10–13 mm latus, oblique oblongus, pilis patentibus 1.0–2.5 mm longis vestitus. *Semina* 6–7 mm longa, 3 mm lata.

TYPE.—Natal, 2829 (Harrismith): 1 km from Fort Mistake to Ladysmith (—BB), Stirton 1417 (PRE, holo.).

Perennial herb, 10–30 cm tall, flowering in early summer. *Stems* erect or decumbent, branching near the base, tawny or ferruginous. *Leaves* mostly 1-foliolate on erect plants and 3-foliolate on decumbent plants, basal leaves always 1-foliolate. *Leaflets* 8.5–11.0 cm long, 4.5–7.0 cm wide, laterals smaller, base cordate, apex acute, terminal and 1-foliolate leaves symmetrical, narrowly to broadly ovate, laterals smaller and oblique, strigose or sericeous,

lower surface dull or shiny, covered with either light yellow or red glands. *Stipules* 10–15 mm long, 4–5 mm wide, ovate-lanceolate, oblique, free, clasping the stem, pubescent. *Petiole* 5–7 mm long. *Racemes* axillary, (10) 20–40-flowered, exceeding leaves, peduncle 5–12 cm long. *Flowers* yellow, rarely pink and yellow, bracts more than half the length of the flower, caducous. *Calyx* 6–7 mm long, lobes equal, teeth triangular or lanceolate, longer than the tube,

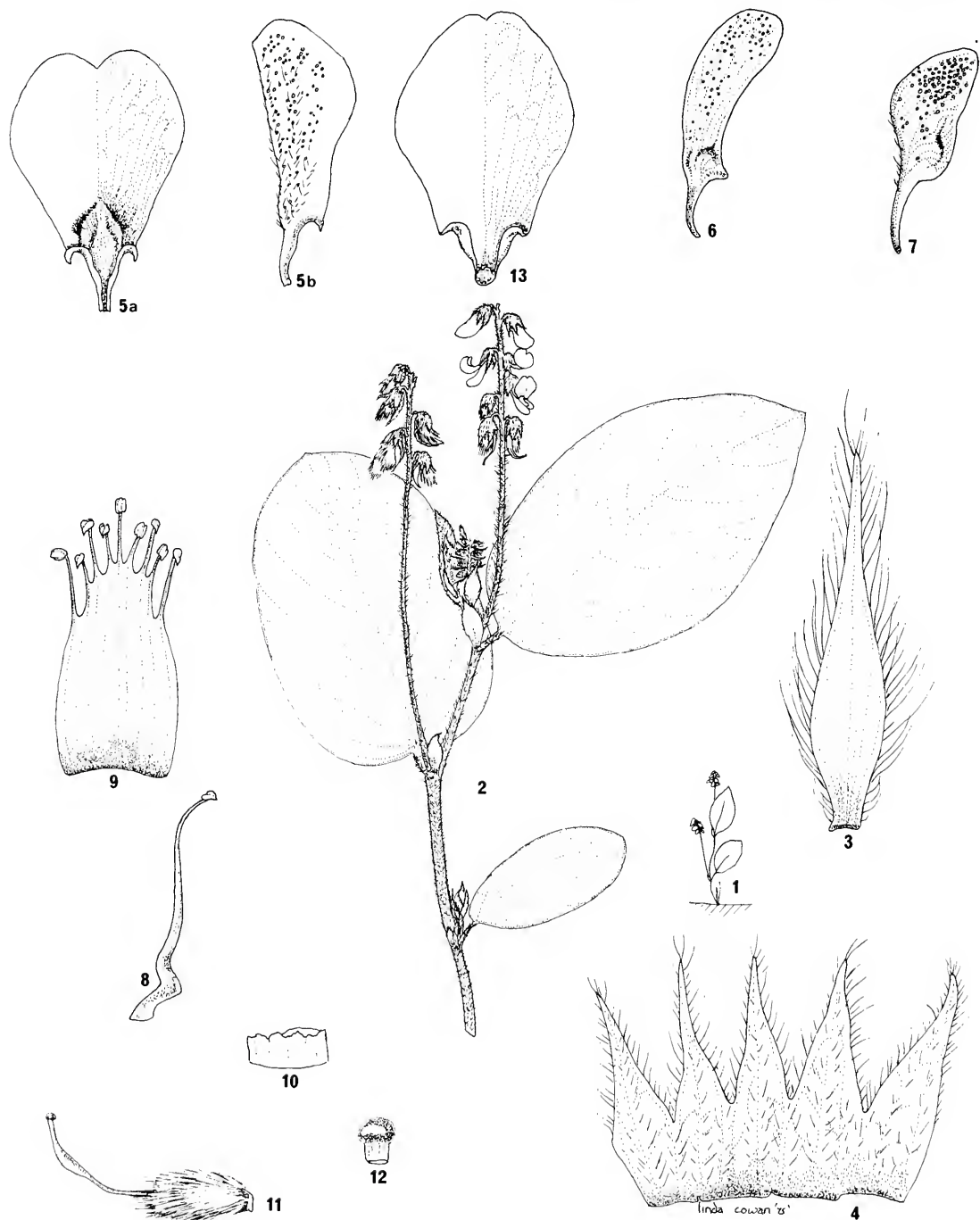


FIG. 15.—*Eriosema lucipetum*. 1, habit, 2, stem with flowers and young fruits, $\times 0.6$; 3, flower bract, $\times 9$; 4, calyx opened out, $\times 6.4$; 5a, standard opened out, $\times 4.6$; 5b, standard closed, $\times 4.6$; 6, wing, $\times 4.6$; 7, keel, $\times 4.6$; 8, vexillar stamen, $\times 6.4$; 9, staminal sheath, $\times 6.4$; 10, discoid floral nectary, $\times 18$; 11, gynoeceium, $\times 6.4$; 12, stigma, $\times 40$; 13, standard opened out, no appendage, $\times 4.6$, from anomalous populations (Stirton 1344).

ferruginous and sparsely pubescent. *Standard* (6) 8–12 mm long, 5–8 mm wide, oblong to obovate; appendages present, situated low down, free or merging into auricles, rarely absent. *Wings* 7–10 mm long, 2–3 mm wide, cultrate, auriculate, sculpturing absent but slightly indented near auricle, longer than the keel. *Keel* 6–8 mm long, 2–3 mm wide, densely glandular, hairy along base, slightly pocketed. *Staminal sheath* 6–7 mm long, free stamen geniculate; anthers uniform, alternately long basifixed and short medifixed. *Gynoecium* 6 mm long; ovary 2–3 mm long, with 0.75 mm long gynophore, densely sericeous, curvature of style 2–3 mm high; stigma capitate. *Nectary* present, high as gynophore, margin undulating. *Fruit* 15–17 mm long, 10–13 mm wide, with a downward pointing 2 mm long beak; obliquely oblong, covered in 1–25 mm long patent hairs. *Seeds* 6–7 mm long, 3 mm wide, polymorphic, either black or light grey and speckled (only one population inspected however). Fig. 15.

Eriosema lucipetum is distributed mainly in northern Natal and northern Kwazulu but also extends as far north as Wakkerstroom in the Transvaal and westwards to Paulina and Rensburgskop in the Orange Free State (Fig. 16).

TRANSVAAL.—2730 (Vryheid): Wakkerstroom (—AC), Beeton 243.

NATAL.—2729 (Volksrust): 28 km from Newcastle to Volksrust (—BD), *Marsh* 69; 10 km from Newcastle to Memel (—DA), *Stirton* 1422; Ingogo (—DB), *Shirley s.n.* NH 30759; 5 km from Newcastle to Memel (—DB), *Stirton* 1420; 15 km from Newcastle to Ladysmith (—DB), *Stirton* 1306; Koenigsburg (—DD), *Thode* 4416. 2829 (Harrismith): Fort Mistake (—BB), *Stirton* 1417; Elandslaagte (—BD), *Shirley* 303; Mpaleni Kop (—DA), *Stirton* 79; 3 km from Colenso to Paulpietersburg (—DB), *Stirton* 1412. 2830 (Dundee): Kelvin Grove (—AA), *Medley Wood* 5184; 8 km from Dundee to Washbank (—AA), *Stirton* 1344; Mpati Mountain (—AA), *Shirley s.n.* 2930 (Pietermaritzburg): New Hanover (—BC), *Stirton* 1309.

O.F.S.—2828 (Bethlehem): Paulina (—AD), *Thode* 4422. 2829 (Harrismith): Rensburgskop (—AC), *Jacobsz* 702. Without precise locality, *Thode* 3332.

This species is easily separated from *E. cordatum* by its free stipules. In areas where the two species overlap there exist plants which may be intermediates. Such plants, because they have free stipules, are included here in *E. lucipetum*. They tend to have pale pink and yellow flowers (for example *Stirton* 1416). Further studies may indicate that they are hybrids.

Eriosema lucipetum is rather variable. Plants from the westernmost part of the range are characterized by their decumbent habit, leaves with upper surface

strigose and under surface shiny with a dense covering of small reddish glands, and calyx ferruginous hispid (Fig. 17). The northern populations usually comprise erect plants with sericeous leaves, the under surface dull and variously covered in white or pale yellow glands; the calyx being white or tawny velutinous. The western plants may bear yellow, pink and yellow and very occasionally red and yellow flowers whereas northern and eastern plants are always yellow-flowered. It is the western plants which overlap in distribution with *E. cordatum*.

Stirton 1344 is a problem specimen to place in *E. lucipetum*. Its general facies is that of the erect form of the northern and eastern parts. It differs from these however in its sharply acute ovate leaves and its differently shaped standard petal that lacks appendages on the inner face. Among the erect plants of the eastern populations there is also an increasing tendency towards the decumbent habit the further east and south one goes. These areas are poorly collected however and it may be that more than one species may be involved. Collections are still needed between the range of *E. lucipetum* and that of the group of yellow-flowered specimens included temporarily under *E. zuluense*. (See under that species.) The latter specimens are included under *E. zuluense* owing to their fused stipules and shortly-triangular calyx teeth.

E. lucipetum is a plant of rocky grassveld, especially rocky banks and along roadsides, usually between 1 900–2 100 m. Flowering begins in October with a peak in November–December and then tails off during March.

The specific epithet *lucipetum* refers to the seemingly light-seeking habit of the inflorescences as they emerge from their rocky habitat.

4. *Eriosema psoraleoides* (Lam.) G. Don, Gen. Syst. 2: 348 (1832); Bak. f. & Haydon, Leg. Trop. Afr. 508 (1929); Staner & De Craene in Anns Mus. r. Congo belge sér 6, 1: 52 (1934); Hauman in F.C.B., 6: 206 (1954); Cufod. in Bull. Jard. bot. État Brux., 25 suppl: 328 (1955); Hepper in F.W.T.A. ed 2, 1: 557, fig. 167 (1958); White, For. Fl. N. Rhod. 151 (1962); Torre in Conspectus Flor. angol. 3: 337 (1966); Verdc. in F.T.E.A. Legum.—Papil.: 772 (1971); Jacques-Felix in Adansonia, sér 2, 11: 157 (1971); Ross, Fl. Natal 208 (1972). Type: Madagascar, Commerson (P, holo.; K, photo.).

Crotalaria psoraleoides Lam., Encycl. 2: 201 (1786), as 'psoraloides'.

Rhynchosia cajanoides Guill. & Perr. in Guill., Perr. & A. Rich., Fl. Sen.: 215 (1832). Type: Verdcourt cites type as Gambia, near Gilfre not far from Albreda, *Leprieur* (P, holo.), but Felix gives type as Senegal, *Perrotet*, (P, holo.).

Eriosema polystachyum E. Mey., Comm. 130 (1836); Meisn. in J. Bot., Lond. 2: 80 (1843). Type: South Africa, Caffraria, *Drege s.n.* (K, iso!).

Eriosema cajanoides (Guill. & Perr.) Hook. f. in Hook., Niger Fl.: 314 (1849); Baker in F.T.A. 2: 227 (1871); Harv. in Fl. Cap. 2: 261 (1862); Medley Wood, Handbook Fl. Natal 43 (1907); Harms in Eng., Pflanzenw. Afr. 3, 1: 673 (1915); Bews, Fl. Natal Zululand 113 (1921); F.W.T.A. 1: 403 (1928); Burt Davy, Fl. Trans. 2: 413 (1932).

Eriosema proschii Briq. in Annu. Conserv. Jard. bot. Genève, 6: 4 (1902); Bak. f. & Haydon, Leg. Trop. Afr. 497 (1929). Type: Zambia, Barotseland, Sefula, *Prosch* 33 (E, holo.).

Perennial shrub or subshrub, 0.6–2.0 m tall. *Stems* erect or suberect, single or few arising from woody rootstock, finely pubescent. *Branches* angular, strongly ribbed; softly white pubescent or fulvocanescent, tomentose, more so on ridges, giving a cha-

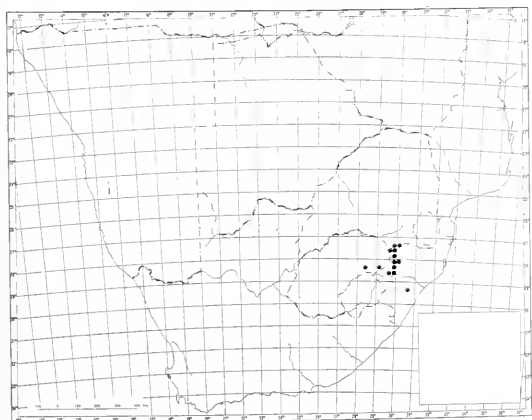


FIG. 16.—Known distribution of *Eriosema lucipetum* in South Africa.

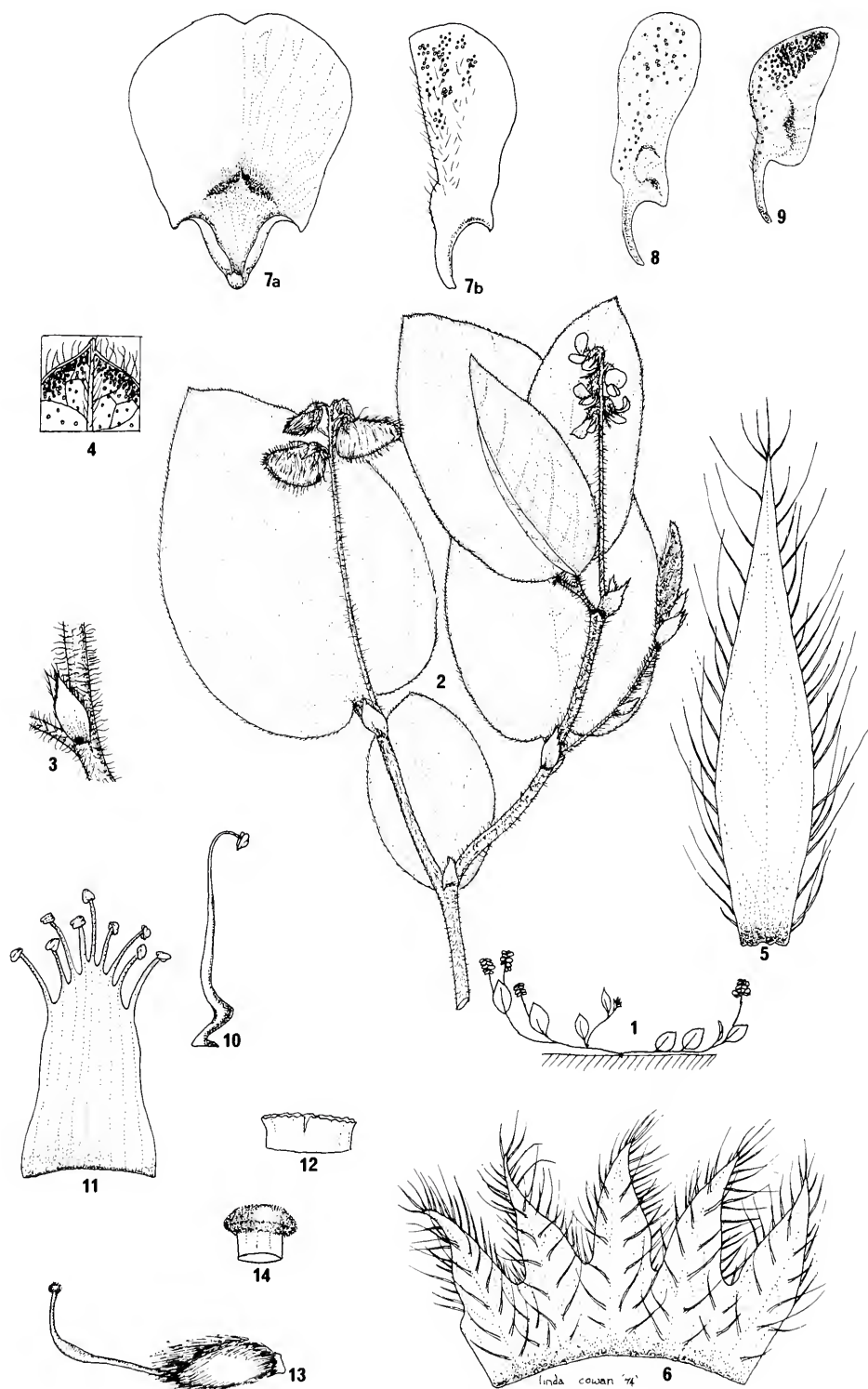


FIG. 17.—*Eriosema lucipetum* (western population). 1, habit; 2, stem with fruits and flowers, $\times 0.6$; 3, free stipules, $\times 0.9$; 4, under surface view of leaflet with glands densely packed along margin, $\times 1.2$; 5, flower bract, $\times 9$; 6, calyx opened out, $\times 6.4$; 7a, standard opened out, $\times 4.6$; 7b, standard closed, $\times 4.6$; 8, wing, $\times 4.6$; 9, keel, $\times 4.6$; 10, vexillar stamen, $\times 6.4$; 11, staminal sheath, $\times 6.4$; 12, discoid floral nectary, $\times 18$; 13, gynoecium, $\times 6.4$; 14, stigma, $\times 40$.

racteristic zebra effect; densely or lightly intermingled with numerous small white to yellow glands, orange in older material. *Leaves* trifoliate. *Stipules* free, up to 5 mm long, often minute, patent or sharply down-flexed, becoming scarious even before subtended leaf expands. *Petioles* 1–4 (5) mm long. *Leaflets* (3,0) 4,5–9,0 (9,5) cm long, 1,5–2,2 (2,8) cm wide, laterals smaller; subcoriaceous; narrow obovate (2:1) to narrow oblanceolate (6:1), or elliptic (2:1) to narrow elliptic (3:1), or oblong (2:1) to narrow oblong (3:1), base cuneate; margin almost revolute; apex rounded or obtuse, less often acute or emarginate; terminal leaflet symmetrical, laterals almost symmetrical, base not oblique; finely sericeous above, characteristically penninerved, discoloured, velutinous beneath giving either a very smooth silvery appearance or a buff and grey appearance; numerous orange glands present, often obscured by dense indumentum. *Young leaflets* hoary. *Petiolules* 2,0–3,0 mm long, more densely hairy than petiole or rachis, slightly swollen often glandular. *Rachis* 1–5 mm long. *Racemes* 10–50-flowered; subdistichous, usually lax; *peduncles* 2,5–4,0 cm long, nearly always less than one third of raceme, finely pubescent, *rachis* 6,0–9,5 cm long. *Flowers* yellow, 11–13 mm long, about 5 mm wide. *Pedicels* \pm 2 mm, semi-erect 30° to axis. *Pedicel bract* 2,0–5,0 mm long, deciduous at bud stage. *Calyx* 4,0–5,5 (6,0) mm long, less than half the length of flower, lobes all equal, teeth length \pm equal to tube, triangular or minaret shaped, with keel tooth sometimes narrower; puberulous inside, shortly pubescent or sericeous outside, with dense orange glands or eglandular. *Standard* 10,3–12,1 mm long, (7,7) 8,0–10,3 mm wide; wide obovate (1,2:1); apex retuse; glabrate or lightly puberulous; claw 1,9–2,0 (2,8) mm long, width between auricles 3,4–5,0 mm, auricles 0,5 mm wide, prominent; appendages absent. *Wings* 10,1–11,5 mm long, 2,1–2,7 (3,0) mm wide; oblong (2:1) to lorate (6:1), cultrate, narrower than but same length as keel blades; claw 2,0–3,0 (3,5) mm long; auricle 1,7–2,0 (3,0) mm high; heel present. *Keel blades* (9,8) 10,0–11,0 (11,4) mm long, (4,1) 4,7–5,8 mm wide; deep pocketed beneath auricle; oblong (2:1); apex subacuate to rounded; claw 2,1–3,2 mm long; auricle (1,8) 2,0–3,0 mm high; covered with numerous small orange glands, often with scattered hairs along base line. *Staminal sheath* 9,0–10,5 mm long, (2,5) 3,5–4,0 mm wide, oblong (2,1); vexillar stamen (8,8) 9,1–11,2 mm long, knee up to 2 mm long. *Gynoecium* 9,5–11,0 mm long; ovary 3,5–4,0 mm long with 0,5–1,0 mm stalk, densely hairy and glandular but hairs hardly exceeding ovary; style very long, partly hairy on base line, incrassated at point of upward flexure; curvature 3,0–3,8 (4,0) mm high, stigma very small, semi-globose, inward angled or erect, inserted. *Discoid floral nectary* 0,5–0,9 mm high, margin smooth, slightly wavy. *Fruit* wide ovate (1,2:1) to very wide oblong (1,2:1), 13–14 mm long, (7) 9–10 mm wide, coriaceous; beak down-turned, up to 1 mm long; densely white or ferruginous villous haired, hairs erect on margins, mostly appressed on sides. *Seeds* khaki or chestnut brown, 5,4–5,9 mm long, 3,4–3,9 mm wide, 1,9–2,0 mm thick, rim-aril cream.

Eriosema psoraleoides extends from West Africa across Central Africa to Sudan, then southwards from east Africa across parts of Zambia to Angola, through Zimbabwe, Mozambique, Botswana, Swaziland into South Africa (Transvaal, Natal). It also occurs in Madagascar, the type country (Fig. 18).

TRANSVAAL.—2229 (Waterpoort): Wyllies Poort (—DD), Hut-

chinson 2096. 2230 (Messina): Tate Vondo Forest Reserve (—CD), Henun 342; Makondo (—DA), Wesphal 38; Lukandwane store, north of Sibasa (—DC), Codd 6881. 2329 (Pietersburg): 8 km above Louis Trichardt (—BB), Rodin 3991. 2330 (Tzaneen): Albasini Dam (—AA), Stephen 291; Tshakoma (—AB), Obermeyer 1054; Westfalia Estate (—CA), Scheepers 141; Tzaneen (—CC), Rogers 12588. 2427 (Thabazimbi): Kransberg (—BC), Gernishuizen 220; Rankins Pass (—DB), Acocks 23587. 2428 (Nylstroom): Near Alma (—AC), Clarke 36; 6 km south-east of Palala (—BC), Story 1662; Nylstroom (—CB), Rogers 75; 12 km from Nylstroom to Naboomspruit (—DA), Coetzer 16. 2429 (Zebediela): Lunsklip (—AA), Maguire 1362. 2430 (Pilgrims Rest): Shilouvane (—AB), Junod 766. 2431 (Acornhoek): 12,3 km from Greenvalley to Nelspruit (—CA), Stirton 1450. 2526 (Zeerust): Groot Marico (—CB), Holland 405/27. 2528 (Pretoria): Wonderboompoort (—CA), Leendertz 704; Bronkhorstspuit (—DD), Grobbelaar 499. 2529 (Witbank): between Grobbeldersdal and Marble Hall (—AB), Grobbelaar 32; Loskop Dam (—AD), Mogg 17242. 2530 (Lydenburg): Sabie Valley (—BB), Galpin s.n.; Wonderkloof Nature Reserve (—BC), Elan Pultick 222; Nelspruit (—BD), Buitendag 127; Mashonamini (—DA), Gross 87. 2531 (Komatiopoort): Pretoriuskop (—AA), Van der Schijff 266; Mlam-bane Dam (—AB), Brynard & Pienaar 4464; Plaston (—AC), Graham 27; Mala Mala (—BA), Johnson 461; Malelane (—BC), Brynard & Pienaar s.n.; Komatiopoort (—BD), Rogers 428; Barberton (—CC), Rogers 28568. 2628 (Johannesburg): Modderfontein (—AA), Hagner s.n.

SWAZILAND.—2631 (Mbabane): 15 km west of Mankaiana (—CA), Compton 28662; Kubuta (—DC), Compton 28128.

NATAL.—2632 (Bela Vista): Ndumu Game Reserve (—CC), Ross 1972; Usutu Flood Plain (—CD), Tinley 532. 2730 (Vryheid): Pongola (—BC), Marguts 115; Zungwini (—DB), Shirley s.n. 2731 (Louwsburg): Itala Nature Reserve (—AC), Brown & Shapiro 423; Mbuzana River, 22 km from Magudu (—DA), Ross 1099. 2732 (Ubombo): Pongola river (—AA), Galpin s.n.; Mkuze (—CA), Galpin 1371; False Bay (—CD), Gerstner 6756; Sodwana Bay (—DA), Balsinhas 3223. 2830 (Dundee): Ingezeraan (—AB), Wood 15069; Qudeni Road to Tissiman's farm (—DA), Hilliard 1379. 2831 (Nkandla): Buxedini (—BB), Guy 90; Eshowe (—CD), Gerstner 4157; 18 km from Eshowe to Gingindlovu (—DC), Stirton 1296; near Empangeni (—DB), Codd 1882; Mtunzini (—DD), Lawn 427. 2832 (Mtubatuba): Hluhluwe Game Reserve (—AA), Ward 1903; Charters Creek (—AB), Baker 10010; Dukuduku Forest (—AC), Strey 5539; Monzi Settlement (—AD), Strey 6567; Richards Bay (—CC), Venter 5458. 2930 (Pietermaritzburg): Inanda (—DB), Wood 160; Umlazi (—DA), Wood 5659; Umlazi (—DD), Wood 11147. 2831 (Stanger): 42 km from Stanger to Mtunzini (—AB), Stirton 408; Chaka's kraal (—AD), Thode 4415; Amatikulu (—BA), Mogg 6289.

Eriosema psoraleoides is one of the most commonly collected *Eriosema* species in southern Africa. It is a very distinctive species and is easily recognized. It has been confused occasionally with *E. salignum* E. Mey., *E. burkei* Benth. and *E. nutans* Schinz, but is readily identified by its leaf shape and pubescence, minute stipules, absence of appendages on the standard, and its congested, short peduncled inflorescence.

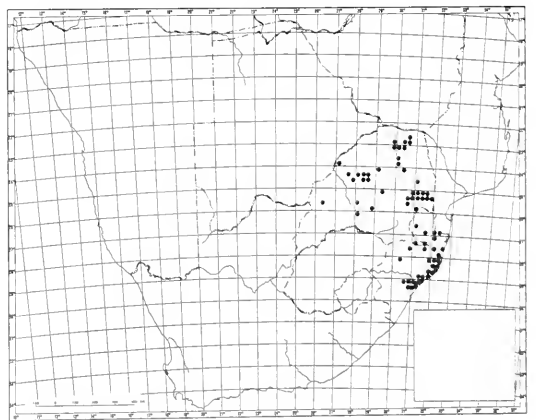


FIG. 18.—Known distribution of *Eriosema psoraleoides* in South Africa.

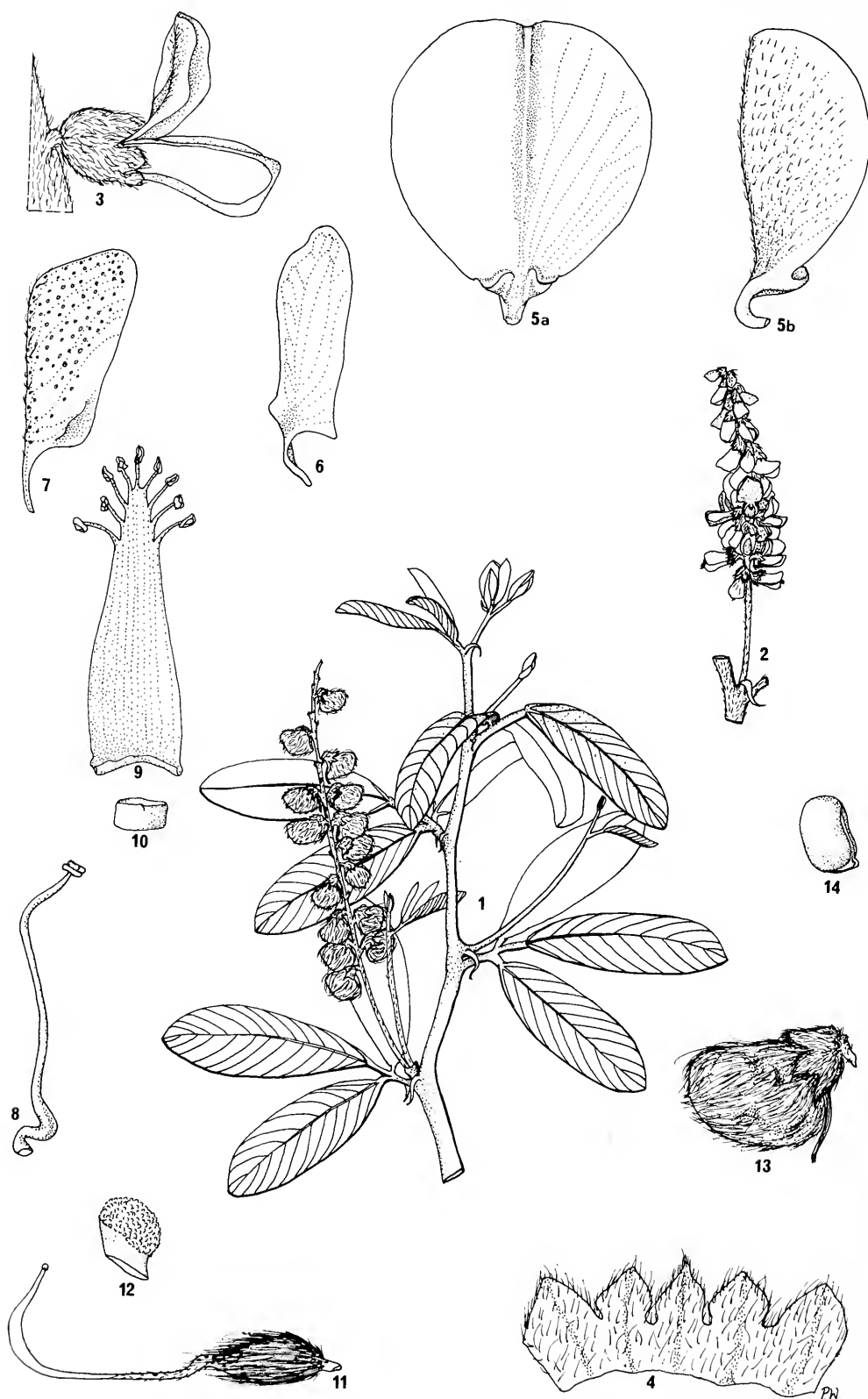


FIG. 19.—*Eriosema psoraleoides*. 1, branch with fruits, $\times 0.6$; 2, inflorescence, $\times 0.6$; 3, flower, $\times 4.6$; 4, calyx opened out, $\times 3.7$; 5a, standard opened out, no appendages, $\times 4.6$; 5b, standard closed, $\times 4.6$; 6, wing, $\times 4.6$; 7, keel, $\times 4.6$; 8, vexillar stamen, $\times 4.6$; 9, staminal sheath, $\times 4.6$; 10, discoid nectary gland, $\times 18$; 11, gynoeceum, $\times 6.4$; 12, stigma, $\times 40$; 13, fruit pod, $\times 1.8$; 14, seed with strophole showing hilum, $\times 2.7$.

The species is restricted to the lower-lying areas of Swaziland, the Transvaal and Natal. It is usually found along roadsides, disturbed crop lands and forest margins, and along coastal sandflats in coarse grassland with scattered shrubs. It has also been recorded in swampy conditions. Field studies have shown that although variable in different environments, it was nevertheless consistent in its important diagnostic characters. Following the road from the Malkerns Agricultural Research Station in Swaziland to Mbabane, I noticed a decrease in size, branching, and number of flowers per inflorescence. A similar gradient occurs between coastal and inland plants.

Eriosema psoraleoides can produce flowers all year round but its flowering is heaviest between October to May with peaks between October to December and March to May. During the period of the second peak the Natal populations, as a whole, flower much later than the Transvaal populations, reaching a peak in April as compared with March. In the first peak the Natal populations flower earlier in September as compared with October–November for the Transvaal.

On the Natal coast plants growing south of Mandini have been observed to flower at different times to those plants growing north of the Tugela River (C. J. Ward, 1975, pers. comm.).

The Venda common name for this species is *mutangasiwa* (Westphal 38, Codd 6881). In Afrikaans it is referred to as the *geelkleurtjie*, an allusion, according to Smith (1966), to their yellow flowers and general appearance to the European *Laburnum*.

Both Gerstner (5002) and Moll (5345) recorded that Tonga and Zulu tribesman cook and eat the ripe seeds. A medicinal use has been observed by Codd (6881) who noted that roots were used to cure internal disorders. These plants apparently are invoked by some Swazi tribesman during storms as a protector against lightning. A less obvious usefulness is the reputed efficacy of their leaves and roots when used as a remedy against venereal diseases; instances having been noted in the Congo, Zambia and Nigeria (Watt & Breyer-Brandwijk, 1962). The same authors also report that in West Africa peasants rub leaves on their dogs in order to control lice.

5. *Eriosema buchananii* Bak. f. in J. Bot., Lond. 33: 145 (1895); Bak. f. & Haydon, Leg. Trop. Afr. 505 (1929); Hauman in F.C.B. 6: 211 (1954); Verdc. in F.T.E.A. Legum.—Papil.: 776 (1971); Agnew, Upland Kenya Wild Flowers 288, icon. (1974). Type: Malawi, Mt Zomba, *Buchanan* 214 (K, holo.).

E. richardii Bak. f. & Haydon var. *ovatum* Staner & De Craene in Rev. Zool. Bot. afr. 24: 286 (1934). Type: Tanzania, Rungwe District, Ukinga Mountains, Madehani, *Solz* 2312 (K, holo.).

Perennial herb or subshrub up to approximately 0.6 m, with simple or sparsely branched, erect stems from a woody rootstock. *Stems* shallowly grooved with scattered orange to red spherical glands, densely covered with spreading ferruginous hairs, longer on the ridges and shorter, erect to appressed, in the grooves. *Leaves* trifoliate, lower leaves often unifoliate. *Stipules* free, 1.0–1.6 mm long, 2.5–4.0 mm wide; lanceolate, base narrower than middle, acinaciform (scimitar-shaped), often falcate; glabrous inside, ferruginous hairy outside. *Petiole* 2–8 mm long. *Leaflets* 3.2–6.8 cm long, 1.0–3.5 cm wide; laterals smaller 1.4–5.9 cm long, 1.0–2.5 cm wide; elliptic (2:1), otherwise ovate (1.5:1) to ovate lanceolate (3:1 or more) base slightly cordate, round-

ed, or truncate; apex acute, mucronate; margin entire, revolute; veins below raised, chestnut coloured and thickly appressed pilose in contrast to shorter, erect pilose areas between veins; veins above thinly appressed pilose; numerous small orange glands scattered below, occasionally above; terminal leaflet symmetrical; lateral leaflets asymmetrical, base oblique, width ratio 1:2. *Young leaves* ferruginous pilose on veins, intervening areas packed with orange glands and softly pubescent to pilose; *petiolules* 2.0–3.0 mm long, acropetiolar parts thickened, blackish, hairs denser. *Rachis* 0.5–1.5 mm long, canaliculate. *Racemes* up to 40-flowered; *peduncle* 5–23 cm long, grooved, glandular, densely covered with a mixture of long and short ferruginous hairs; *rachis* 2–6 cm long; *pedicels* erect about 60° to axis, 1.0–1.5 mm long, recurved at apex, glabrous at base just above bract abscission scar. *Calyx* (4,0) 4.5–5.0 (5,7) cm long; externally spreading pilose and gland dotted, with shorter hairs near the base, and longer denser hairs on the lobes and creases; internally finely hairy on lobes but restricted mainly to veins and the horn lobes; *tube* 2.0–3.0 mm long, being longer between the horn lobes, 2.3–3.3 mm long, circumference 5.0–5.3 mm, tissue distinctly bulged between the horn lobes when the calyx is flattened; lobes triangular unequal, horn lobes partly connate, 4.2–5.2 mm long; lateral lobes 3.9–5.0 mm long, keel lobe 4.0–5.7 mm, longest; lobes more or less equalling the tube. *Standard* very pale pink lined with dark purple; 7.7–10.7 mm long, 3.0–4.6 mm wide; oblong (2:1), narrowed in the middle, appendages occur above the middle and are slight ridges often difficult to see; claw 2.2–3.6 mm; auricles prominent, incurved, 3.5–4.5 mm apart. *Wings* 7.3–9.0 mm long, 1.8–2.0 mm wide, longer than keel, ratio 1:1.2; narrowly oblong (3:1); claw 2.5–3.5 mm, auricle 1.2–1.9 mm high. *Keel blades* 6.1–8.0 mm long, 2.0–2.6 mm wide at maximum; claw 2.0–3.0 mm long; a few hairs along baseline, glandular. *Staminal sheath* 5.2–6.5 mm long, 1.9–2.6 mm wide at maximum, vexillar stamen 4.5–6.2 mm long, basal knee 0.5–0.8 mm long. *Gynoeceum* 5.0–7.2 mm long; ovary 2.0–3.0 mm long, with stalk 0.3–1.0 mm long; hairs on ovary wall up to 2.5 mm long, distinctive, wavy, not stiff; style slightly bent and thickened towards end; curvature 1.1–2.0 mm high; stigma small capitate, inserted. *Discoid floral nectary* 0.3–0.6 mm high, margin slightly wavy, often revolute. Fruits and seeds not seen. Fig. 20.

In South Africa this species is confined to a few localities in the northern Transvaal (Fig. 21). It appears to be restricted to the North-eastern Mountain Sourveld Veldtype. It occurs between 900 and 1 490 m. The Transvaal is the southernmost limit of distribution. It is also recorded from Kenya, Uganda, Tanzania, Zambia, Malawi and Zimbabwe.

TRANSVAAL.—2329 (Pietersburg): Haenertsburg (—DD), Eastwood 13 & Pott 4635, 2330 (Tzaneen): Duivelskloof (—CA), *Scheepers* 814; Magoebaskloof (—CA), Papendorf 275; Woodbush (—CC), Mogg 13992.

Verdcourt (1971) in his treatment of *Eriosema* for the Flora of Tropical East Africa reported that he had seen only one specimen of var. *buchananii* from South Africa. This specimen, *Scheepers* 814, has proved however to be the most atypical of the South African specimens. It has larger more distinctly ovate leaves, longer peduncles as well as a shorter lighter patent indumentum. This may be due to environmental influences as similar attributes have also been noted in field studies in other species in the *E. cordatum* complex. *Scheepers* 814 groups well with the



FIG. 20.—*Eriosema buchananii* var. *buchananii*. 1, branch with flowers, $\times 0.6$; 2, stipule, $\times 4.6$; 3, flower bract, $\times 9$; 4, calyx opened out, $\times 6.4$; 5a, standard opened out, $\times 4.6$; 5b, standard closed, $\times 4.6$; 6, wing, $\times 4.6$; 7, keel, $\times 4.6$; 8, vexillar stamen $\times 4.6$; 9, staminal sheath, $\times 4.6$; 10, discoid floral nectary, $\times 18$; 11, pistil, $\times 6.4$; 12, stigma, $\times 40$.

following specimens from outside South Africa: *Chaje* 682 (Zimbabwe); *Corby* 1430 (Zimbabwe); *Hilliard & Burt* 4139 (Malawi); *Pawek* 1564, 8046 (Malawi); *Richards* 2362/A (Tanzania); *Semsei* 1652 (Tanzania). These specimens might deserve some infraspecific ranking. Verdcourts inclusion of var. *buchananii* in the *E. cordatum* E. Mey. complex can be understood from his comments on the *Scheepers* 814 specimen. He referred to *Scheepers* 814 as being a 'small rounded shrub of upright habit with numerous ascending to suberect branches from the base, corolla very pale pink, veined with dark red purple'. In differentiating between *E. cordatum* and *E. buchananii* in South Africa, he made some relevant remarks, based as it turned out, on a specimen atypical of its range. He commented: 'This is most interesting because the same collector has collected true *E. cordatum* at Letaba [*Scheepers* 487, 3 Oct. 1958 (K; PRE)]; he described the flowers as yellow veined with dull red, the standard dull red outside. The two are strikingly similar in general appearance save that *Scheepers* 814 has much denser patent indumentum on the stem. The two are, however, equally strikingly different in their standards; not only is there the difference in the appendages already pointed out, but the shape is also quite different in each. *E. buchananii* has a distinctly rectangular standard with the auricles pronounced, above which it is very slightly narrowed; *E. cordatum* has a distinctly obovate standard, gradually narrowed into the claw, the auricles being less obvious. Moreover the claws of the other petals are much longer in *E. buchananii* than they are in *E. cordatum*'.

Scheepers (1974 pers. comm.) felt sure his Nos 487 and 814 were different — 'certainly they are very distinct in habit'. He commented on *E. buchananii*'s 'more stiffly upright habit' as opposed to *E. cordatum*'s 'characteristically laxly sprawling habit'.

These comments hold for all the other specimens of *E. buchananii* in South Africa which are clearly distinct and easily separable from *E. cordatum*. I suspect that their relationship is probably not as close as previously envisaged.

In South Africa *E. buchananii* has been confused more often with two other species rather than with *E. cordatum*. Here it has been known under the name *E. nutans* Schinz [= *E. polystachyum* (A. Rich.) Bak.] to which it has a very strong resemblance, and also to *E. montanum* Bak. f. which does not extend as far south as South Africa. *E. buchananii* may be readily separated from the rest of the complex by the

presence of an appendage situated above or at the middle of an oblong standard, the large incurved flattened auricles and the falcate stipules with the base narrower than the middle. The appendage is characteristic as it is divided into two shallow, crescentiform ridges which lie closely one on either side of the central axis of the standard. *E. nutans* is separated by its smaller auricles and its undivided appendage which occurs just above the auricles merging into them.

Apart from the comment by *Mogg* (13992) that his plant was 'common in grassland ridges of gneiss', there is very little ecological information for the species in South Africa. *Scheepers* 814 has the following note 'north facing slope, intense sunlight to misty or windy, periodically moist well drained and aerated to dry, arid shallow soil tending toward lateritic type'.

E. buchananii flowers from November to January, with a peak in December.

There is another variety in east Africa, var. *subprostratum* Verdc. This does not occur in South Africa. *Gillett* 17669 (K) from Tanzania, which has been included under var. *subprostratum* seems to me to be worthy of some rank. It has smaller flowers, lacks the typical *buchananii* stipules and has a different pubescence.

6. *Eriosema nutans* Schinz in Bull. Herb. Boissier sér 2, 8: 629 (1908); Bak. f. Leg. Trop. Afr. 1: 505 (1929); Burt Davy, Fl. Transv. 2: 15, 413 (1932); Verdc. in Kew Bull. 25: 121 (1971). Type: South Africa, Transvaal, Shilouvane, *Junod* 2165 (Z, holo.).

E. richardii Bak. f. & Haydon, Leg. Trop. Afr. 505 (1929). Type: Ethiopia, without locality, *Schimper* 708 (K, holo.).

E. richardii Bak. f. & Haydon forma *ellipticum* Staner & De Craene in Rev. Zool. Bot. afr. 24: 286 (1934). Type: Kenya Gishu, *Harvey* 71 (K; holo.! PRE, iso.).

E. buchananii Bak. f. var. *richardii* (Bak. f. & Haydon) Staner forma *ellipticum* (Staner & De Craene) Staner in Kew Bull. 278 (1935).

E. polystachyum sensu auctt. e.g. Bak. in F.T.A. 2: 225 (1871); Burt Davy, Fl. Transv. 2: 413 (1932); non (A. Rich.) Bak., nec E. Mey., non *Rhynchosia polystachya* A. Rich.

Perennial herb or subshrub 30–90 cm tall from underground rootstock. *Stems* erect or decumbent, branched, grooved, densely or lightly covered with ± spreading white or ferruginous hairs and shorter curly hairs on ridges, ± glabrous in troughs. *Leaves* trifoliate; *stipules* free, 5–9 mm long, 1.0–1.5 mm wide, linear lanceolate or triangular, straight or falcate, closely veined, not recurved, appressed hairy outside, glabrous inside ± glands. *Petioles* 3–7 mm long. *Leaflets* 4–8 cm long, 1.3–2.8 cm wide, laterals much smaller; narrow ovate (2:1) to lanceolate (3:1), or elliptic (2:1); apex acute or rounded; base cuneate or truncate, margin revolute; terminal leaflet symmetrical, laterals almost symmetrical, base mostly oblique; shortly appressed pilose above, appressed pilose on raised venation beneath but sparsely erect pilose between veins; both surfaces covered with either large orange or small yellow glands or both without. *Young leaflets* shaggy white or ferruginous, ± densely packed with glands. *Petiolules* 1–2 (3) mm long. *Rachis* (0.7) 0.8–1.1 (1.2) cm long. *Racemes* axillary, 10–43-flowered; *peduncle* 4.0–12.2 cm long, densely or sparsely ferruginous or white hairy; *rachis* (3.2) 4.0–7.2 (11.1) cm long; *Flowers* yellow (7.0) 7.5–9.0 (10.0) mm long, (2.5) 3.0–3.4 mm wide, reflexed; bract 3.0–5.8 mm long, lanceolate slightly boat-shaped, caducous, hairy outside,

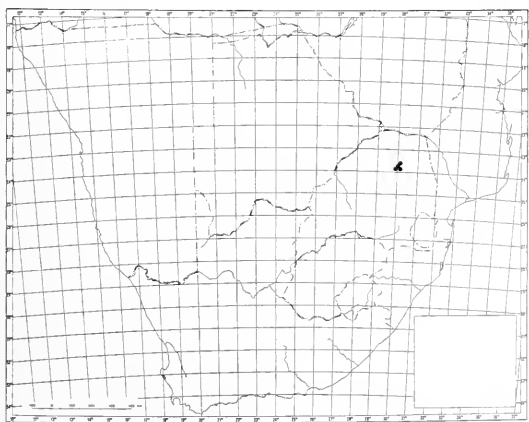


FIG. 21.—Known distribution of *Eriosema buchananii* in South Africa.



FIG. 22.—*Eriosema nutans*. 1, habit; 2, branch with fruits and flowers, $\times 0.6$; 3, flower bract, $\times 9$; 4, flower, $\times 4.6$; 5, calyx opened out, $\times 9$; 6a, standard opened out, $\times 4.6$; 6b, standard closed, $\times 4.6$; 7, wing, $\times 4.6$; 8, keel, $\times 4.6$; 9, vexillar stamen, $\times 9$; 10, staminal sheath, $\times 9$; 11, discoid floral nectary, $\times 18$; 12, gynoecium, $\times 9$; 13, stigma, $\times 40$; 14, fruit pod, $\times 2.8$.

glabrous inside; calyx (3,0) 3,5–4,3 (4,5) mm long, lobes \pm equal, deltoid or triangular, \pm yellow or orange glands, shortly pilose, long hairs if present mostly at tips or along veins; tube (1,5) 2,0 (2,9) mm long, longer between horn lobes (1,9) 2,2–2,8 (3,6) mm long; lateral lobes (3,0) 3,5–4,0 (4,5) mm long; keel lobe (3,0) 3,5–4,2 (4,5) mm long, horn lobes longest (3,1) 4,0–4,3 (4,8) mm long, tips straight, occasionally incurved; basal circumference 4,0–5,0 mm. *Standard* (6,7) 7,0–9,2 (10,0) mm long, (2,5) 2,8–4,0 (4,5) mm long, mostly oblong (2:1), densely hairy on back, glands present or absent; claw (1,0) 1,5–2,0 (2,8) mm long; width between auricles (2,2) 3,0–3,3 (4,0) mm; auricles prominent; appendage situated low down and extending across auricles, bifurcate, two upcurled flaps 2,7–3,6 (4,0) mm from base of claw. *Wings* (4,2) 6,9–7,8 (8,8) mm long, (0,9) 1,0–1,1 (1,6) mm wide at maximum, about same length as keel blades, sparsely glandular and hairy on outside, claw (1,7) 2,0–2,5 (3,2) mm long; auricle 1,0–1,2 (1,6) mm high. *Keel blades* (6,0) 7,0–8,0 mm long, (0,9) 2,5–2,8 (3,3) mm wide at maximum, 2–3 times wider than wing, either densely packed with glands or eglandular, prominently hairy along base line up curvature to apex, claw 2,0–2,5 (3,0) mm long, auricle 1,2–1,5 (1,8) mm high. Staminal sheath (5,5) 6,0–7,0 (7,1) mm long, (1,2) 1,9–2,2 mm wide at maximum, vexillar stamen (5,2) 6,0–6,8 (7,0) mm long. *Gynoeceium* (5,4) 6,0–7,2 (8,5) mm long; *ovary* (2,2) 2,8–3,0 mm long with short haired stalk, 0,2–0,5 mm long; glandular with long silky sericeous hairs reflexing at tips and extending as far as thickening in style; style filiform but thickened at point of flexure, curvature (1,5) 2,0–2,1 (2,2) mm high; stigma minutely capitate, inserted. *Discoid floral nectary* with margin crenulate. *Fruits* ovate-oblong, 10–12 mm long, 6–8 mm wide, beak oblique 0,5–1,1 mm long, covered with long soft ferruginous hairs and short hairs, longer hairs mostly at top and sides, short appressed hairs distinctive along base line as it incurves towards stem. *Seeds* 3,0–3,5 mm long, 1,6–2,0 mm wide; black, strophiole cream or white. Fig. 22.

In South Africa *E. nutans* is confined to the Transvaal and Swaziland (Fig. 23). Elsewhere it occurs in Zaire, Sudan, Ethiopia, Eritrea, Kenya, Uganda, Tanzania, Malawi, Zambia, Mozambique and Zimbabwe.

TRANSVAAL.—2329 (Pietersburg): Louis Trichardt (–BB), Breyer s.n.; Bloodriver (–CD), Hay s.n. 2330 (Tzaneen): Elim (–AA), Schlechter 4550; Westfalia Estate (–CA), Grobbelaar 426; Modjadjes Reserve near Duiwelskloof (–CB), Krige 29; New

Agatha (–CC), McCallum s.n. 2428 (Nylstroom): Tarentaalpas (–AD), Clarke 360. 2430 (Pilgrims Rest): The Downs (–AA), Junod 4354, Shilouvane (–AB), Junod 2165, 4896; Pilgrims Rest (–DD), Rogers 14510, 2528 (Pretoria): Pretoria (–CA), Repton 241. 2530 (Lydenburg): Lydenburg (–AB), Galpin 12194; Mount Anderson (–BA), Galpin 13720. 2627 (Potchefstroom): Krugersdorp (–BB), Jenkins 9228. 2628 (Johannesburg): Melville Koppies (–AA), McNae 1455; Boksburg (–AB), Murray s.n. 2629 (Bethal): Standerton (–CD), Rogers 4813.

SWAZILAND.—2631 (Mbabane): Mliwane Game Reserve (–AC), Arnold 832.

Burtt Davy (1932) accepted both *E. nutans* Schinz and *E. polystachyum* (A. Rich.) Bak. He remarked that *E. nutans* Schinz 'is a close ally of *E. polystachyum* (A. Rich.), Bak. f. ms'. Under *E. polystachyum* (A. Rich.), Bak. he stressed its close affinity to *E. richardii* Benth. ex Bak. f. Later, however, he cited Rogers 14510 as *E. polystachyum* but labelled it *E. richardii*. His treatment of these various taxa can be understood and appreciated after reading a note on pp 15–16 of his flora. In this note on 'Synonyms and References' Burtt Davy commented on some of the difficulties he encountered with synonymy. His example fortuitously concerned *Eriosema polystachyum*. He said: 'For the sake of space, also, only so much synonymy has been given as seemed requisite to correlate the species with the "Flora Capensis" and the "Flora of Tropical Africa", or with more recent revisions and monographs. The principle has been adopted that the same name should not be used for more than one plant, even though the first name so applied has been reduced to the rank of a synonym. This rule has much to commend it in view of the fact that differences of opinion will always exist as to the correctness of reducing a name to the status of a synonym, and the consequent liability that the plant to which it was first applied will be restored to specific rank. An example in point is that of the Tropical African *Eriosema polystachyum* (A. Rich.) Bak. (1871); *Rhynchosia polystachya* A. Rich. (1847); this is antedated by *Eriosema polystachyum* E. Mey. (1835), which is a distinct species, of the Transkei. Although Meyer's name has been reduced to a synonym of *E. cajanoides* (Guill. & Perr.) Benth. *Rhynchosia cajanoides* Guill. & Perr. (1833), it is quite possible that the Transkeian *E. polystachyum* is not conspecific with *E. cajanoides*, in which case Meyer's name would have to be restored and Richard's name would have to be changed, and with consequent confusion. Probably anticipating this, Bentham proposed in mss, the name *Eriosema richardii*, which is adopted here'. [N.B. *E. polystachyum* E. Mey. is a synonym of *E. psoraleoides* (Lam.) G. Don].

E. nutans has been interpreted differently in different parts of Africa, a not unusual result of the slow, spasmodic development of African botany. This name has been used rarely in South Africa. Here the most popular name has been *E. polystachyum* (A. Rich.) Bak. In referring to practice outside South Africa, Verdcourt (1971) made the following comment: 'During the past thirty years this (*E. nutans* Schinz) has mostly been accepted as a variety of *E. buchananii* but I am certain that the two are best kept distinct, the latter differing in large leaves, much broader stipules, different position of the standard appendages and less constancy in flower colour. The flowers of *E. nutans* are yellow but only a few plants of *E. buchananii* have been seen with yellow flowers; they are mostly cream, pink, or purple lined with purple'.

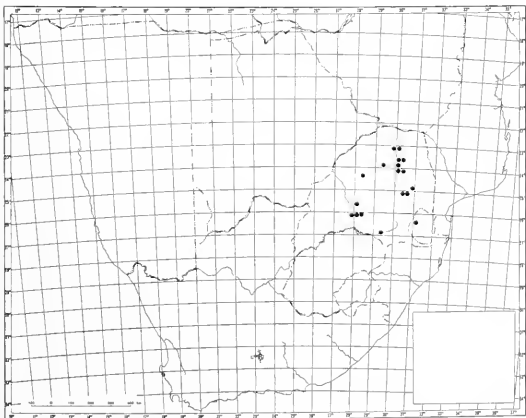


FIG. 23.—Known distribution of *Eriosema nutans* in South Africa.

As the presence of *E. buchananii* has now been firmly established in the Transvaal, I might add that Verdcourt's comments hold for South Africa, except that here plants of *E. buchananii* have not been recorded as yellow-flowered.

Over 50 specimens had been incorrectly named in the past. This material had been referred to *E. psoraleoides* (*E. cajanoides*), *E. parviflorum*, *E. zeyheri* and *E. squarrosom*. *E. psoraleoides* with its very small stipules, wide obovate standard without appendages, different keels, wings and pistil is easily separated from *E. nutans* which has an oblong standard with appendages and long lanceolate stipules. The two species differ also in that in *E. nutans* the peduncle is longer than half the length of the inflorescence. In *E. psoraleoides* the peduncle is less than one third the length of the inflorescence. *E. parviflorum* is distinguishable from *E. nutans* by its wide obovate (1,2: 1) standard, and its allopatric distribution (almost restricted to Natal in S. Africa).

The most noticeable variation which occurs in *E. nutans* is the presence or absence of glands. Two types of glands have been found; large and small red glands and yellow glands. Gland colour may be the result of ageing or an artefact of the poisoning of herbarium specimens. Glands are mostly confined to specimens from the northern Transvaal. Glandular and non-glandular plants both extend from Tanzania to the Transvaal. Calyces are quite variable ranging from sparsely short pilose and short toothed, to long toothed and densely short pilose. Leaf shape and size are most variable. Stipules range from short triangular and slightly falcate, to long linear-lanceolate and straight. This variation may be worthy of infra-specific categorization. However, in view of the numerous difficulties of synonymy which have resulted from regional demarcations of infra-specific ranks, I have left this to later workers who may see the species in a broader African perspective.

E. nutans grows mainly in the bushveld and open grasslands and has been found on south-facing hillsides, in disturbed areas such as dipping tanks, in cultivated fields and near marshy ground. It flowers from November to May with a definite peak in February to March.

The Venda name for this plant is reported by the Reverend Rogers (No. 4813) to be Mutzikedzi.

7. *Eriosema parviflorum* *E. Mey.*, Comm. 130 (1836); Meisn. in J. Bot., Lond. 2: 80 (1843) Harv. in Fl. Cap. 2: 260 (1862); Bak. in F.T.A. 2: 225 (1871); Bak. f. in J. Bot., Lond. 33: 142 (1893); Wood & Evans, Natal Plants 1: 73–74 (1899); Harms in Warb., Kunene-Samb. Exped.: 265 (1903); Medley Wood, Handbook Fl. Natal 43 (1907); Bews, Fl. Natal Zululand 113 (1921); Bak. f. & Haydon in Leg. Trop. Afr. 504 (1929); Staner & De Craene in Annls Mus. r. Congo belge sér 6, 1: 60, fig. 9 (1934); et in Rev. Zool. Bot. afr. 24: 288 (1934); Rossberg in Feddes Reprint 33: 166 (1936); Hauman in F.C.B. 6: 211 (1954), pro parte; Hepper in F.W.T.A. ed. 2, 1: 557 (1958), pro parte; Verdc. in Kew Bull. 25: 124–125 (1971); Verdc. in F.T.E.A. Legum.—Papil.: 778 (1971); Jacques-Felix in Adansonia, sér 2, 11: 169–170 (1971); Ross, Fl. Natal: 208 (1972). Lectotype: South Africa, Natal, between Umzimkulu River and Umkomaas River, Drège (K!).

The synonymy of *Eriosema parviflorum* is puzzling. There is little agreement among the three latest studies, and as the chosen example below indicates, it is a problem the solution of which rests in a full

African study. The chosen example concerns the treatment of the name *Eriosema parviflorum* var. *sarmentosa* Staner & De Craene. Keay (1973) assigned this to *E. parviflorum* subsp. *parviflorum*, whereas Verdcourt (1971a) placed it under *E. parviflorum* subsp. *podostachyum* (Hook. f.) J. K. Morton. Jacques-Felix (1971), however, excluded it from *E. parviflorum* completely and made it a synonym of *E. spicatum* Hook. f. Unlike both Keay and Verdcourt, he did not recognize infraspecific categories in *E. parviflorum*. This example forms part of a confused pattern. Rather than add to this confusion I have decided not to recognise any infraspecific categories in the region under study until the species has been studied over its entire range.

Perennial spreading suffrutex up to 60 cm high, arising from underground woody rootstock. *Stem* erect, branching near base, apical growth arrested with development of branches. *Branches* ascending or decumbent, up to 1 m long, slightly ridged; thinly white pubescent or densely shaggy with deflexed ferruginous hairs on older parts but admixed with smaller white hairs on younger; white or red glandular on younger parts. *Leaves* rarely unifoliate (at base), trifoliate, exhibiting nastic response. *Stipules* free, (4) 5–8 (10) mm long, 1,0–2,0 mm wide, spreading and reflexed when old turning red brown as leaflets expand; lanceolate, linear, or if tear-shaped then blackish at base. *Petiole* (1,1) 1,3–2,2 (3,0) cm long, canaliculate, vesture thickest on ridges. *Leaflets* 2,0–6,2 cm long, 1,0–3,2 cm wide, laterals smaller but 1/w ratio less, elliptic (2:1) or wide elliptic (1,5:1), occasionally tending to suborbiculate (1,2:1), narrow obovate (2:1); base rounded, if tapered then narrow truncate or narrow cordate; apex obtuse to rounded, rarely acute; margin entire; terminal leaflet symmetrical, laterals asymmetrical, base oblique; finely pubescent on both surfaces, with white or orange glands. *Young leaflets* densely pubescent, hairs longer appressed on raised veins, with densely packed red or white glands. *Petiolules* 1–2 mm long, swollen, terete, shaggy and glandular. *Rachis* 0,2–0,6 mm long. *Racemes* 5–54 flowered; peduncles elongate, (5) 7–13 (16) cm long, shortly densely spicato-racemose at summit, deflexed white or ferruginous hairy; *rachis* (1,2) 2–5 (6) cm long. *Flowers* yellow, 5–6 mm long, \pm 2,5 mm wide; pedicels 1,0–1,5 mm long, recurved; *bracts* 2,5–4,0 mm long, shortly triangular, caducous. *Calyx lobes* (2,0) 2,5–3,0 mm long, half length of flower; lobes equal; teeth shorter than or equalling tube, triangular with keel tooth often pinched into finger-like process, pubescent with short appressed hairs, occasionally longer haired especially near extremities, glandular. *Standard* (5) 6–7 (8) mm long, 3,0–4,2 (4,6) mm wide, wide obovate (1,2:1) occasionally narrow obovate (2:1), apex \pm rounded; 1/b ratio 1,5–1,8; glabrescent or sparsely pubescent and glandular outside; claw 1,9–3,1 mm; width between auricles 1,0–2,0 mm, inflexed auricles very prominent; appendage situated low down and extending across auricles, (2,0) 2,2–2,4 (2,7) mm from base of claw. *Wings* (4,9) 5,0–6,0 (6,7) mm long; 2,0–2,5 mm wide at maximum, shape variable when in position, shorter than keel blades, glabrous or pubescent, claw (1,0) 1,8–2,0 (2,1) mm long; auricle 1,0–1,1 (1,3) mm high, 'step' present. *Keel blades* 5,2–6,0 (6,6) mm long, 2,0–2,6 mm wide at maximum, obtuse slightly incurved, densely glandular; claw (1,1) 2,0–2,1 mm long; auricle 1,0–1,1 (1,5) mm high. *Staminal sheath* (4,0) 5,0–5,5 (5,8) mm long, 2,0–2,2 (2,7) mm wide at maximum, oblong (2:1); vexillar stamen (4,0) 5,0–5,3 (6,0) mm long. *Gynoecium*

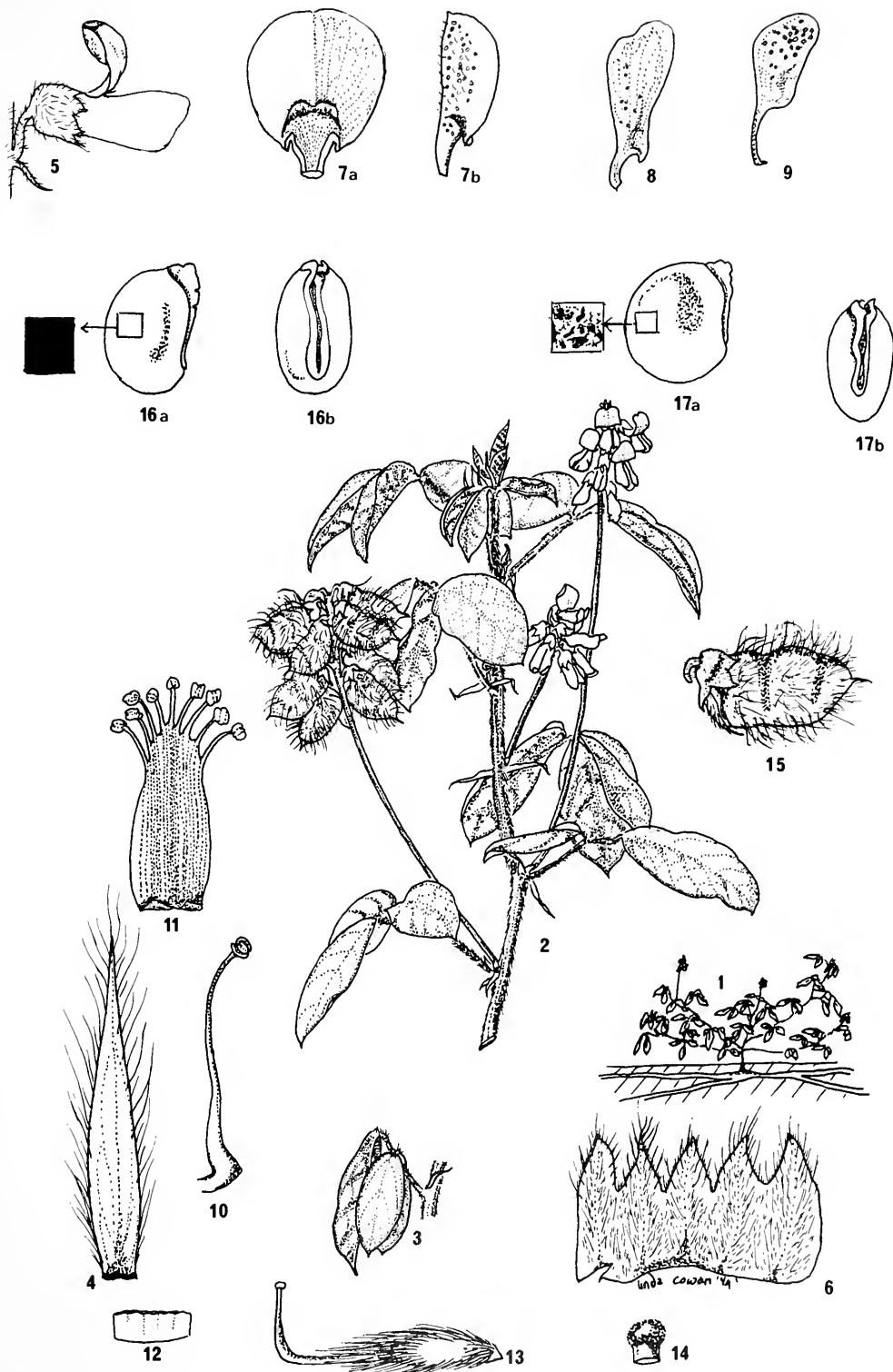


FIG. 24.—*Eriosema parviflorum*. 1, habit, 2, branch with fruits and flowers, $\times 0.6$; 3, leaves epinastic, night position, $\times 0.6$; 4, flower bract, $\times 9$; 5, flower, $\times 4.6$; 6, calyx opened out, $\times 9$; 7a, standard opened out, $\times 4.6$; 7b, standard closed, $\times 4.6$; 8, wing, $\times 4.6$; 9, keel, $\times 4.6$; 10, vexillar stamen, $\times 6.4$; 11, staminal sheath, $\times 6.4$; 12, discoid floral nectary, $\times 18$; 13, gynoecium, $\times 6.4$; 14, stigma, $\times 40$; 15, fruit, $\times 2.1$; 16a, black seed with strophiole, face view, $\times 6.4$; 16b, black seed with strophiole, marginal view showing hilum, $\times 6.4$; 17a, khaki, grey speckled seed with strophiole, face view, $\times 6.4$; 17b, khaki, grey speckled seed with strophiole, marginal view showing hilum, $\times 6.4$.

5.0–6.1 mm long; ovary (2.1)–2.6 (3.0) mm long, stalk 0.2–0.5 mm long shortly hairy but glabrous underneath; densely covered with glands and yellow or white hairs extending almost to point of curvature; style glabrous, variable in shape, aberrations common, thickened at curvature, incurved or erect, curvature (1.0) 1.4–1.8 (2.1) mm high; stigma small, capitate, sometimes incurved; inserted. *Discoid floral nectary* folded, slightly rippled. *Fruits* 0.9–1.2 cm long, 0.6–0.7 cm wide; obliquely oblong (2:1) to wide oblong (1.5:1), beak straight or slightly upturned, up to 1 mm long; strongly compressed; shaggy with foxy hairs and fine pubescence, hairs longer and wispier on sides, glandular. *Seeds* 3.5–3.7 (4.0) mm long, (2.3) 2.5–2.6 mm wide, 1.1–1.5 (2.1) mm thick, polymorphic, khaki with purple flecks and speckles, or chestnut, or black, rim aril white black seeds longer but thinner and narrower than speckled seeds. Fig. 24.

Eriosema parviflorum extends eastwards from west Africa across the Camerouns and Congo to the Sudan and east Africa, then southwards through Zambia and Mozambique into South Africa (Transvaal and Natal) (Fig. 25). It also occurs in Madagascar.

TRANSVAAL.—2230 (Messina): Sibasa, north of Pepiti (—CD), *Smuts & Gillett* 3287.

NATAL.—2632 (Bela Vista): Kosi Estuary (—DD), *Moll & Strey* 3685. 2732 (Ubombo): Sordwana Bay (—BC), *Stephen, Van Graan & Schwabe* 1095; Lake Sibayi (—DA), *Vahrmeijer & Hardy* 1625. 2831 (Nkandla): Eshowe (—CD), *Lawn* 84; Empangeni (—DB), *Venter* 1894; Ngoye Forest Reserve (—DC), *Huntley* 250; Mtunzini (—DD), *Stirton* 413. 2832 (Mtubatuba): Palm Ridge Farm (—AC), *Harrison* 382; Richard Bay (—CC), *Stirton* 534. 2930 (Pietermaritzburg): Shongweni (—CD), *Ross* 778; Inanda Mountain (—DB), *Hilliard* 2043; Isipingo Flats (—DD), *Ward* 6807. 2931 (Stanger): Between Blythedale Beach and Tugela Bridge (—AD), *Stirton* 396, 795; Berea, Durban (—CC), *Medley Wood* 1448, 3030 (Port Shepstone): 8 km from Winklespruit along Eston road (—BB), *Stirton* 1123; St Michaels-on-Sea (—CD), *Nicholson* 773; Hibberdene (—DA), *Grobbelaar* 67.

TRANSKEI.—3129 (Port St Johns): Magwa Falls (—BC), *Galpin* 10985; Port St Johns (—DA), *Hilliard* 1066, 1111. 3130 (Port Edward): Mnyameni Mouth (—AA), *Acocks* 13396.

Eriosema parviflorum E. Mey. is mostly restricted to the alluvial coastal plain of Natal. It grows in open moist grassland, coastal forest margins, damp marshland and bushy sand dunes. It seems to favour a south-west aspect and an altitude range of 5–650 m.

There is a variation in robustness and leaf size in this species. Figs 26 & 27 show the ranges possible.

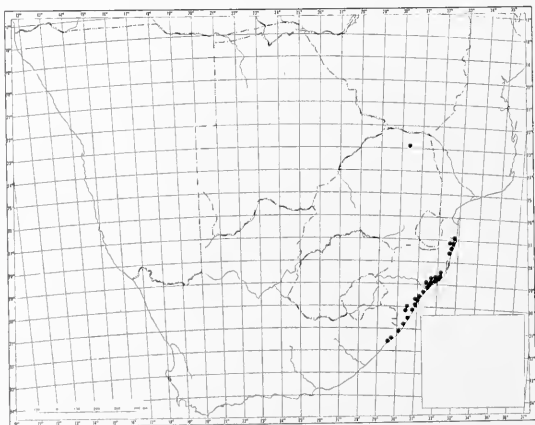


FIG. 25.—Known distribution of *Eriosema parviflorum* in South Africa.



FIG. 26.—Huntley 250, large-leaved form of *E. parviflorum* collected in the Ngoye Forest Reserve (1963–02–07).



FIG. 27.—Ross 778, small-leaved form of *E. parviflorum* collected at Shongweni (1964–03–08).

The large leaved forms are rare. Stem pubescence, gland colour, size of stipules and number of flowers also vary to some extent, but apart from this the species is fairly constant throughout its range.

In Natal *E. parviflorum* has a tendency to produce floral aberrations. I have recorded and preserved an unusually large number of cases in which up to three standards were present in the same flowers. The most common aberration found was a variation in the shape of the pistil. Two forms occurred, sometimes in the same plant. The area of thickening may be at the point of flexure or above it. Beyond the point of flexure the style may be erect or strongly recurved. This may constitute an example of cleistogamy. Another common aberration is the lack of, or partial fusion of the stamens into a staminal sheath. Keel blades are often absent. This information is recorded in case difficulties are encountered in keying out the species. The wing is an unreliable character.

An unusual feature is the occurrence of 'sleep movements'. I have been unable to determine whether these are photonastic or thermonastic. They are definitely not thigmonastic. Fig. 24.2 and 24.3 shows the same plant during the day and later during the night. The leaflets expanded during the day can be seen to have closed tightly to the petioles at nightfall.

This species was recorded by Phillips (1917) for Lesotho. He based this citation on *Dieterlen* 866. A study of this specimen has revealed that it has characters intermediate between those of *E. cordatum* var. *cordatum* and *E. salignum* E. Mey. The possibility of hybridization cannot be ruled out (Stirton, 1981). Plants such as *Dieterlen* 866 were probably common since Phillips (*l.c.*) referred to it by its Lesotho name, 'Leshetla la loti', a name different from those he recorded for the putative parents. I am certain that his specimen is not *E. parviflorum* E. Mey. and that this species does not occur in Lesotho.

E. parviflorum has no close affinities in South Africa. It has often been confused with *E. nutans* Schinz, but differs from that species in the shape of the standard and the shape of the seeds.

Plants flower from early September to as late as April.

ACKNOWLEDGEMENTS

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UITTREKSEL

Die Eriosema cordatum E. Mey. kompleks word in 'n aantal spesies gesegregeer. *E. cordatum* E. Mey. word as 'n veelvormige spesies behou, en twee verwante spesies, *E. lucipetum* C. H. Stirton en *E. zuluense* C. H. Stirton word as nuut beskryf. Vier bykomende spesies *E. buchananii* Bak. f., *E. nutans* Schinz, *E. psoraleoides* (Lam.) G. Don en *E. parviflorum* E. Mey. word hersien en uitgesluit uit die *E. cordatum* groep.

REFERENCES

- ALLSOPP, R. J., 1947. Notes on the ecology of associated grassveld plants of Pietermaritzburg, South Africa. M.Sc. thesis, University of Natal (unpublished).
- BRYANT, A. T., 1909. Zulu medicine and medicine men, *Ann. Natal Mus.* 2: 1-104.
- BURITT DAVY, J., 1932. *A manual of the flowering plants and ferns of the Transvaal with Swaziland, South Africa*. 2. London: Longmans Green.
- CORBY, H. D. L., 1974. Systematic implications of nodulation among Rhodesian legumes. *Kirkia*. 9: 301-329.
- DILCHER, D. L., 1974. Approaches to the identification of Angiosperm leaf remains. *Bot. Rev.* 40, 1: 1-157.
- FREY-WYSSLING, A., 1955. The phloem supply to the nectaries. *Acta bot. neerl.* 4: 358-369.
- GREAR, J. W., 1970. A revision of the American species of *Eriosema* (Leguminosae-Lotoideae), *Mem. N. Y. bot. Gdn* 20, 3: 1-98.
- GROBBELAAR, N., VAN BEYMA, M. C. & TODD, C. M., 1967. A qualitative study of the nodulating ability of legume species: List 1. *Publs Univ. Pretoria*. New sér 38: 1-9.
- GROBBELAAR, N. & CLARKE, B., 1972. A qualitative study of the nodulating ability of legume species: List 2. *Jl S. Afr. Bot.* 38, 4: 247.
- HARVEY, W. H., 1862. *Eriosema* DC. In W. H. Harvey & O. W. Sonder, *Flora Capensis*, 2: 259-262. Dublin: Hodges, Smith.
- HEPPER, E. N., 1973. *Eriosema* DC. In J. Hutchinson & M. Dalziel, *Flora of West Tropical Africa*, ed. 2 revised by R. W. Keay 1, 2: 555-559 (1958). London: Crown Agents for Overseas Govts. & Admins.
- HICKEY, L. J., 1973. Classification of the architecture of dicotyledonous leaves. *Am. J. Bot.* 60, 1: 17-33.
- JACOT GUILLARMOD, A., 1971. *Flora of Lesotho (Basutoland)*. Lehre: Cramer. 474 pp.
- JACQUES-FÉLIX, H., 1971. Observations sur les espèces du genre *Eriosema* de République centrafricaines, du Cameroun et d'Afrique occidentale. *Adansonia* sér. 2, 11: 141-199.
- LAWRENCE, G. H. M., 1960. *Taxonomy of vascular plants*. New York: Macmillan. 823 pp.
- MOORE, J. A., 1936. The vascular anatomy of the flower in the papilionaceous Leguminosae. *Am. J. Bot.* 23: 349-354.
- PHILLIPS, E. P., 1917. A contribution to the flora of the Leribe Plateau and environs. *Ann. S. Afr. Mus.* 16: 1-379.
- PHILLIPS, E. P., 1951. The genera of South African flowering plants, ed. 2, *Mem. bot. Surv. S. Afr.* 25: 923 pp.
- POYNTON, J. C., 1964a. The amphibia of southern Africa: a faunal study. *Ann. Cape Prov. Mus.* 2: 252-272.
- POYNTON, J. C., 1964b. The biotic division of southern Africa, as shown by the amphibia. 206-218. In D. Davis, *Ecological studies in southern Africa*. The Hague: W. Junk. 415 pp.
- ROE, K. E., 1971. Terminology of hairs in the genus *Solanum*. *Taxon* 20: 501-508.
- SMITH, C. A., 1966. Common names of South African plants. *Mem. bot. Surv. S. Afr.* 35. 642 pp.
- STANER, P. & DE CRAENE, A., 1934. Les *Eriosema* de la Flore Congolaise. *Annls Mus. r. Congo belge* sér. 6, 1, 2: 1-90.
- STEARNS, W. T., 1973. *Botanical Latin*. Newton Abbot: David & Charles. 566 pp.
- STIRTON, C. H., 1975. *A contribution to knowledge of the genus Eriosema (Leguminosae, Lotoideae) in southern Africa (excluding Mozambique and Rhodesia)*. M.Sc. thesis, University of Natal, Pietermaritzburg, 182 pp. (unpublished).
- STIRTON, C. H., 1977. The identity of *Eriosema nanum*. *Bothalia* 12: 199-203.
- STIRTON, C. H., 1978. The *Eriosema cordatum* complex. 1. The *Eriosema populifolium* group. *Bothalia* 12: 395-404.
- STIRTON, C. H., 1981. Studies in the Leguminosae-Papilionoideae of southern Africa. *Bothalia* 13: 317-325.
- STIRTON, C. H., 1981. Hybridization in *Eriosema* (Papilionoideae) in southern Africa. *Bothalia* 13: 307-315.
- STUCKENBERG, B. R., 1969. Effective temperature as an ecological factor in southern Africa. *Zoologica Afr.* 4, 2: 145-197.
- VAN DIJK, D. E., 1971. The zoocartographic approach to Anuran ecology. *Zoologica Afr.* 6, 1: 85-117.

- VERDCOURT, B., 1971a. Studies in the Leguminosae-Papilionoideae for the flora of tropical east Africa, *Kew Bull.* 25: 65–169.
- VERDCOURT, B., 1971b. *Eriosema* DC. In E. Milne–Redhead & R. M. Polhill In *Flora of Tropical East Africa, Leguminosae-Papilionoideae*, 761–805. London: Crown Agents for Overseas Govt & Admins.
- WADDLE, R. M., 1968. See Waddle, R. M. & Lersten, N. R. 1974.
- WADDLE, R. M. & LERSTEN, N. R., 1974. Morphology of discoid floral nectaries in Leguminosae, especially tribe Phaseoleae (Papilionoideae). *Phytomorphology* 23: 152–161.
- WATT, J. M. & BREYER-BRANDWIJK, M. G., 1962. *The medicinal and poisonous plants of southern and eastern Africa*. 2. Edinburgh & London: Livingstone. 1457 pp.
- WHITE, F., 1971. The taxonomic and ecological basis of chorology. *Mitt. bot. StSamml., Münch.* 10: 91–112.

Natural hybridization in the genus *Eriosema* (Leguminosae) in South Africa

C. H. STIRTON*

ABSTRACT

Both spontaneous and introgressive hybridization occur naturally in *Eriosema* in South Africa. One case of hybrid swarming is reported and a catalogue of six hybrids is presented and discussed in detail.

RÉSUMÉ

HYBRIDATION NATURELLE DANS LE GENRE *ERIOSEMA* (LEGUMINOSAE) EN AFRIQUE DU SUD

L'hybridation naturelle et introgressive survient naturellement chez l'*Eriosema* d'Afrique du Sud. Un cas d'essaimage d'hybride est rapporté dans un catalogue de six hybrides et est présenté et discuté en détail.

INTRODUCTION

Although hybridization is today widely recognized as having played a major role in the evolution of the plant kingdom, there is still disagreement (Heiser, 1973) as to how it should be defined. For example, Sibley (1957) defined it as interbreeding between populations in secondary contact, regardless of taxonomic rank, whereas Solbrig (1970) differentiated clearly between the crossing of different taxa, calling that between species, or taxa of higher rank, 'hybridization', and that within species 'recombination'. In this paper the term hybridization is used in Mayr's (1942) sense of 'the crossing of individuals belonging to two unlike natural populations that have secondarily come into contact'.

Most authors who have written on this subject recognize two main types of hybridization: spontaneous hybridization and introgressive hybridization. Naturally occurring interspecific hybrids, presumably individuals of the first filial generation (henceforth referred to as the F_1), are known in all major groups of plants and in all well studied floras (Grant, 1971). According to this author the F_1 generation may be fertile, semi-sterile, highly sterile, or completely sterile, and in all but the last case it can produce some later-generation progeny. The partially fertile F_1 hybrid may reproduce sexually, be selfing, or there may be crossing with sister hybrid plants, or backcrossing to one or both parental species. The resulting second-generation progeny can then go on to cross with one another and with the original plants. This results in a hybrid swarm, an extremely variable mixture of species, hybrids, backcrosses, and later-generation recombination types.

In this study the term 'spontaneous hybridization' is used in reference to the production of occasional or sporadic natural hybrids, whereas the term 'introgressive hybridization' refers to the repeated backcrossing of a natural hybrid to plants of one, or both, parental populations.

Three hybrid situations have been encountered in the present study. These are:

- (a) *spontaneous hybridization* between two species, with the hybrid progeny sterile;
- (b) *introgressive hybridization* between two species, with the hybrid progeny semi-sterile or fertile;
- (c) *hybrid swarming* between four species with the hybrid progeny of variable fertility.

Representative examples of spontaneous and introgressive hybridization have been selected from the hybrid catalogue and are presented in detail. The only hybrid swarm encountered is briefly referred to, as its detailed analysis was considered beyond the scope of this work. The three hybrid situations listed above form the framework on which the hybrid catalogue has been compiled. It is presented in the last section.

The structure of populations of plants derived through hybridization have been evaluated almost exclusively on the basis of morphological criteria (Levin, 1967). Their analysis has been possible by the development of a number of techniques such as Anderson's (1949, 1953, 1956, 1957) pictorialized scatter diagrams and hybrid indices and to a lesser extent Hatheway's (1962) weighted hybrid index. However, as Levin (1967) clearly pointed out, these techniques, although they provide considerable information about the gross population structure, the direction and extent of gene flow, and the correlation and segregation of species characters, they nevertheless may fail to provide a basis of ascertaining the specific nature of each hybrid. As a consequence of dominance, character cohesion, epistasis, complex mode of inheritance, varying degrees of expressivity and phenotypic plasticity Levin (1967) considers any judgements concerning parentage of individual organisms to be unreliable. Clearly comparative morphology alone is inadequate in portraying the dimensions and significance of hybridization: it can however, indicate its physical presence and, from a practical taxonomic viewpoint, can provide an adequate preliminary tool of analysis.

For over 30 years Anderson's paradigm of character coherence, the basis of his concept of introgressive hybridization, has been very useful to taxonomists dealing with hybrid populations. There is now, however, sufficient data to suggest that this paradigm should be considerably modified (Flake, Rudloff & Turner, 1969; Adams & Turner, 1970; Heiser, 1973; Anderson & Harrison, 1979; Grant, 1979; Wells, 1980). The Andersonian theory has been succinctly summarized by Grant (1979) as follows: 'Character coherence is a diagnostic feature of natural hybrid populations. The character coherence is due primarily to multifactorial linkage and secondarily to pleiotropy and environmental selection. Selection in nature normally favours parental types and thus works in the same direction as linkage'. What has troubled Grant (1979) and other authors is the limiting scope of Anderson's theory as well as the misleading interpretations that can arise from its faulty techniques. The latter has been clearly shown

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by Wells (1980). The biggest stumbling block in Andersonian theory is the finding (Grant 1979) that different hybrid populations may have marked differences in character coherence. Grant has suggested, therefore, that character coherence is not a constant, but rather a variable feature of natural hybrid populations. Two new techniques are now available to detect this (Grant 1979; Wells, 1980). The nub of Grant's conclusion is that multifactorial linkage and recombination are opposing tendencies and that in hybrid populations they work in balance such that their respective expressions of character coherence and character recombination will reflect a balance or compromise between opposite extremes. He suggests that 'the balance is affected by various internal and external factors. The components of the recombination system of the plant group comprise the internal factor (see Grant 1975, Chap. 3); the chief external factor is natural selection. The interplay between these factors determines the point of equilibrium between character coherence and character recombination and so will vary from hybrid population to hybrid population depending on the controlling factors involved.

This study has utilized Andersonian techniques as these were all that were available at the time. Unfortunately the present author has no further opportunities to continue this study and presents the results in the hope that someone will reassess the problem in greater depth using chemical and cytological data and a revised Andersonian paradigm.

Eriosema is one of the few papilionoid genera in southern Africa which is known to have undergone hybridization. The reason for this propensity is unknown. It is interesting that *Rhynchosia*, a genus close to and often confused with *Eriosema*, has not a single recorded case of hybridization. Judging from reported cases hybridization among papilionoid legumes is an apparently rare phenomenon. This may, however, be due to a lack of appreciation by taxonomists of its role in plant variation. The chemotaxonomic studies of *Baptisia* by Alston and Turner and co-workers remain the classic case of hybridization analysis in the Papilionoideae (Alston, 1959; Alston, Turner, Lesters & Horne, 1962; Alston & Turner, 1963; Alston & Hempel, 1964; Alston, 1965) and a useful model to follow if suitable facilities are available.

1. SPONTANEOUS HYBRIDIZATION

While collecting specimens on vacant commonage at Hayfields, Pietermaritzburg (Fig. 1), I found a large population of yellow flowered *E. salignum* E. Mey., growing below a ridge on a gentle slope. South of this was an extensive population of prostrate, bright red, orange and yellow flowered *E. cordatum* E. Mey. In the adjacent area between the two species and also within the *E. cordatum* population were about twenty semi-erect, pale pink and yellow-flowered plants (Fig. 2), most of which bore withered flowers and fruits. Some of the fruits were fully formed but the enclosed seeds had shrivelled. The vesture of hairs of these twenty proved to be intermediate between those borne by plants of *E. salignum* and *E. cordatum* that grew in the same general area. I decided to analyse the entire population.

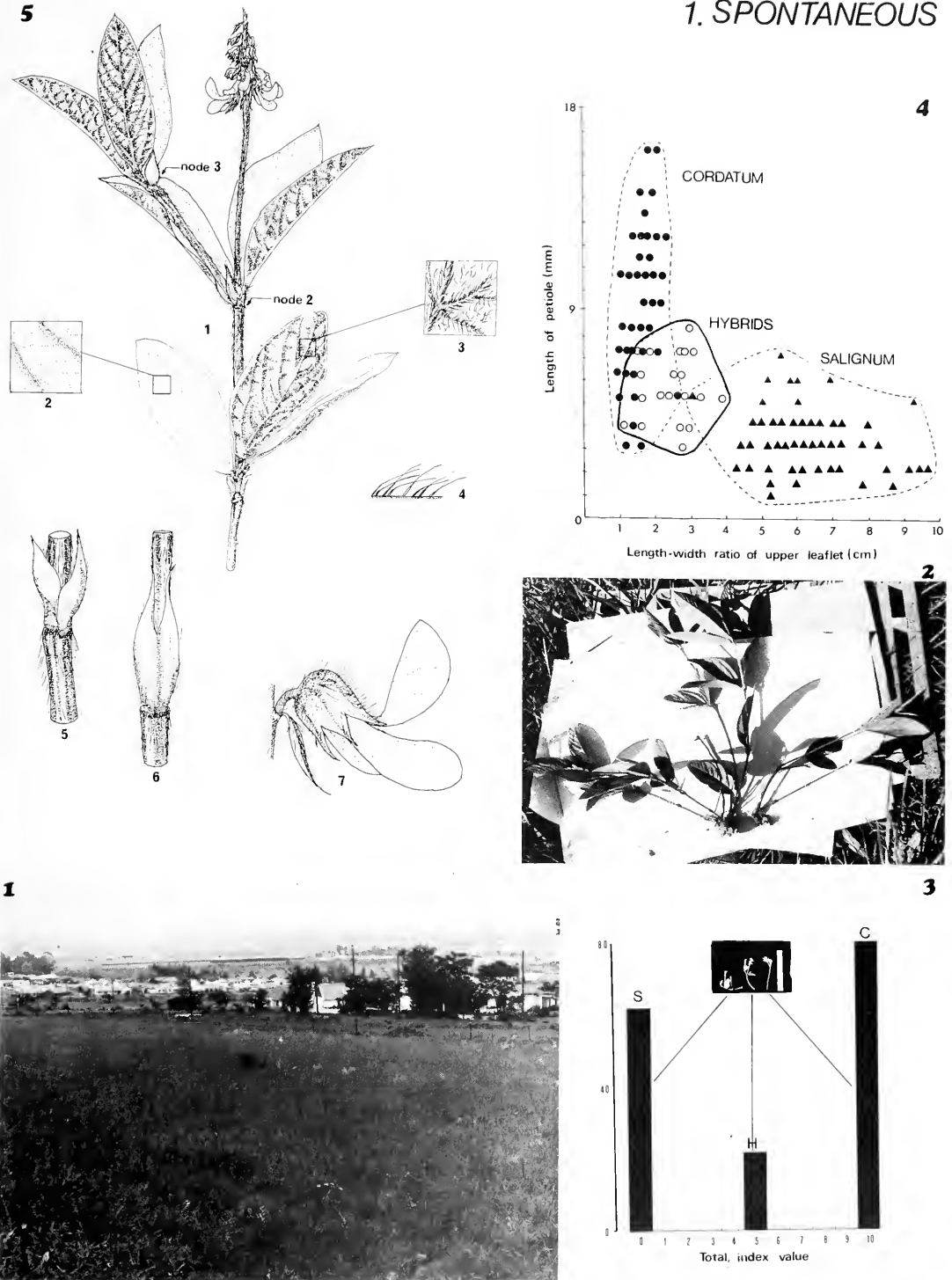
After considering the possible influence of slope, shade and soil type, I laid out four transects that provided an adequate sample of the area. I collected all plants of *Eriosema* that grew within 1 m of these lines. At 50 m intervals, I then made right-angled transects along which I also collected all plants within 1 m distance from the transect.

As fruiting and flowering were almost completed at time of first locating the population, emphasis had to be placed upon the morphological form of vegetative characters. A record was made of each plant's habit of growth, the degree of senescence of the stipules and the type and density of stem and leaf vesture. The length and width of the terminal (upper) leaflet of the mature trifoliolate leaf subtending the first produced inflorescence, and the length of the petiole of the same leaf were also noted. The qualitative morphological characters are listed in the left hand column of Table 1. Each character was divided into three states. Those states representative of plants of *E. salignum* were given the value 0; those representative of plants of *E. cordatum* carried the value 2, while intermediates were represented by value 1. One hundred and fifty two plants were scored for these character states. The sum of the index values for all character states of an individual comprises its total index value. Theoretically the total index value for plants of *E. salignum* was thus 0, that for plants of *E. cordatum* was 10, while for hybrid plants scores from 1-9 were possible. Plants with similar total index

TABLE 1. — Characters and index values used in scoring the hybrid population at Hayfields, Pietermaritzburg

Characters	0	1	2
Habit	erect	semi-erect	prostrate
Form of stipules	free	connate at base	connate, 2/3 of length
Persistence of stipules	senescent	senescing	persistent, green
Stem vesture	dense, fine appressed	dense, shaggy appressed	sparse, shaggy patent
Pubescence of undersurface of leaflet	appressed hairs along veins, woolly in intercostal areas	surface dull, hairs semi-erect on veins and in intercostal areas	surface shiny, with sparsely scattered erect hairs

1. SPONTANEOUS



FIGS 1 — 5.—Spontaneous hybridization. 1, fallow commonage near Scottsville. 2, *Stirton* 736: plant collected at Hayfields, Pietermaritzburg (1974–02–21). 3, frequency distribution of total index values of the *Eriosema* population at Hayfields, Pietermaritzburg (S, *E. salignum*; H, 'hybrid'; C, *E. cordatum*). 4, pictorialized scatter diagram of population of *E. salignum* and *E. cordatum*, and putative hybrids growing at Hayfields, Pietermaritzburg (sampled 1974–12–01). 5, *Stirton* 1601: plant collected at Hayfields, Pietermaritzburg (1975–01–22), probably a hybrid between *E. cordatum* and *E. salignum* — 1, stem with flowers, $\times 0.5$; 2, glabrous abaxial surface of lateral leaflet, $\times 3$; 3, hairy adaxial surface of terminal leaflet, $\times 3$; 4 semi-erect hairs of stem and adaxial surfaces of leaflets; 5 free stipules at node 2, $\times 2.8$; 6, fused stipules at node 3, $\times 2.8$; 7, flower, $\times 4.3$.

values were grouped into a frequency distribution (Fig. 3). The 21 intermediate plants all fell into class 5 of the frequency distribution. The 61 plants which had individual total index values of 0 were considered to belong to *E. salignum*, whereas those plants which had a total index value of 10 were considered to belong to *E. cordatum*. Only one group of plants was found to be intermediate, namely those falling within class 5.

Quantitative parameters were combined with the qualitative character states by constructing a pictorialized scatter diagram (Fig. 4). In this diagram the value of the ratio of leaflet length/leaflet width was plotted against the length of the petiole.

In Fig. 4 the hybrids (open circles) are seen to occupy an area of the graph intermediate between the main area of variation occupied by each putative parent. The hybrid is not entirely discrete spatially as a number of specimens of both putative parents fall within its range.

Fig. 4 and Table 1 both indicate the presence of a group of plants with characters that are not those of *E. salignum* nor those of *E. cordatum* but more or less intermediate between these.

A resampling of this population on the 22-10-1975 produced a plant (Fig. 5) which, although clearly within the range of the intermediate plants referred to above, showed some features that are worth special mention. The stipules, instead of senescing, persisted and remained green. They also varied from free and overlapping at the base (Fig. 5.5) to fused for two-thirds their length (Fig. 5.6). It would be advantageous to monitor an area such as the one described, for hybrids and hybrid variation throughout several years to attempt to obtain information relating to maternal and pollen parents of the hybrids that grew and flowered at different times and especially to ascertain whether the nature of the spontaneous hybrids varied over time.

In the Hayfields area the location of the hybrid plants in relation to the populations of both putative parental species suggested that the hybrids arose from seed shed by *E. cordatum*. Plants of *E. cordatum* always set abundant seed, whereas those of *E. salignum* produced a poor, erratic seed set. This level of seed set has been found to be consistent for these

taxa throughout their range. Bruchid damage was also heavier in seeds of *E. salignum*.

2. INTROGRESSIVE HYBRIDIZATION

Of common occurrence in *Eriosema* in South Africa are populations in which two species are readily recognized but in which a range of 'intermediates' are also present.

The example discussed in this section was located near Sobantu village, Pietermaritzburg (Fig. 6). Two species occurred: *E. cordatum* and *E. preptum* C. H. Stirton.

The habitat consisted of heterogeneous soil conditions that ranged from clay in burnt grassveld to deep sand on the lip of a bare roadbank. The latter site formed the limit of distribution. The roadbank was fully exposed to the sun, whereas the grassland had a fair number of plants of *Acacia* that provided shade.

Plants were analysed as in the example described previously. A field assessment of their range of variation revealed two characters with marked quantitative variation, namely the length of the inflorescence and the length of the terminal leaflet of a mature trifoliate leaf. Measurements were recorded for 136 plants.

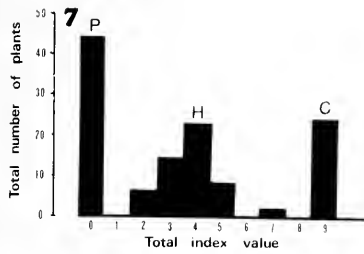
The qualitative characters are listed in the left hand column of Table 2. Each character was divided into 3 or 4 states. The numerical value of the character states provides an index value. Total index values were compiled for each plant and then used in the compilation of a frequency distribution (Fig. 7) by the method used previously. The scoring of individual plants was such that a typical plant of *E. preptum* would score 0, one of *E. cordatum* would score 9, whereas plants with characters of either putative parent would score from 1 to 8.

Fig. 7 shows that nearly 50 % of the plants scored fell between the two putative parents. Fig. 8 is typical of the plants falling in group 4 in Fig. 7. From Fig. 7 it appears that there was backcrossing of the interspecific hybrids with plants of *E. preptum*.

The quantitative characters were combined with the various qualitative character states and are presented in a pictorialized scatter diagram (Fig. 9). It

TABLE 2. — Characters and index values used in scoring the hybrid population at Sobantu Village, Pietermaritzburg

Characters	0	1	2	3
Stem vesture	short white with longer appressed hairs interspersed	semi-erect short white hairs with spreading yellow hairs interspersed	ferruginous, stiff spreading hairs only	
Gland colour on calyx	yellow	orange	white	
Habit of growth	erect	semi-erect or ascending	prostrate	
Under-surface of leaflets	dense white woolly with longer appressed hairs on veins yellow glands interspersed	sparsely woolly, longer hairs more erect, yellow glands	scattered hairs, erect, orange glands, surface dull	scattered hairs erect, white glands, surface shiny

STEM PUBESCENCE

- short white hairs with longer appressed hairs interspersed
- ◐ short white hairs with spreading yellow hairs interspersed
- stiff, spreading, ferruginous hairs

GLAND COLOUR ON CALYX

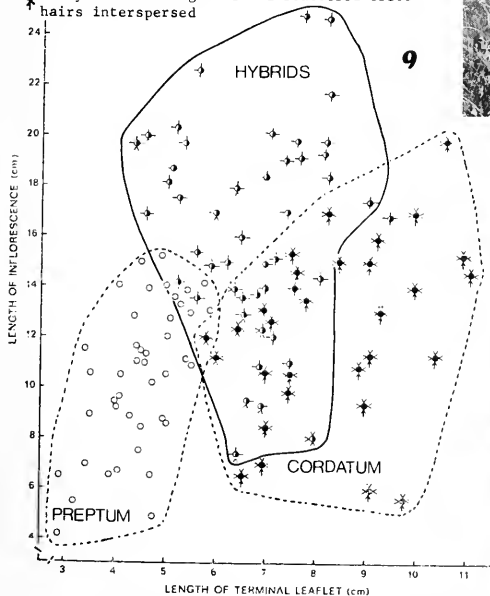
- yellow
- ◐ orange
- white

PLANT HABIT

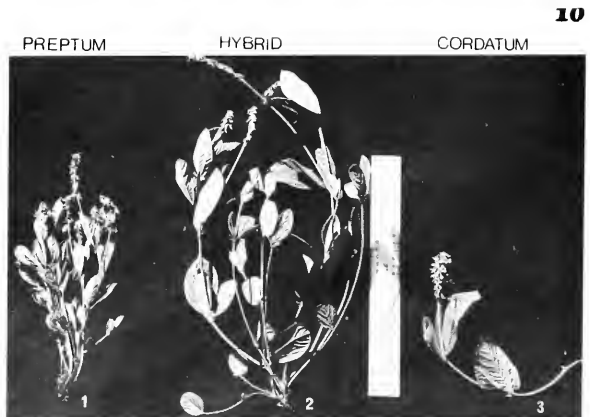
- erect
- ◐ semi-erect or ascending
- prostrate

UNDERSURFACE OF LEAVES

- dense white woolly with longer appressed hairs on the veins. Yellow glands interspersed
- ◐ sparsely woolly with longer erect hairs, and yellow glands interspersed
- ◑ dull with orange glands and scattered erect hairs interspersed
- shiny with white glands and scattered erect hairs interspersed



2. INTROGRESSIVE



FIGS 6-10.—Introgressive hybridization. 6, open grassland with scattered *Acacia* trees near Sobantu Village, Pietermaritzburg. 7, frequency distribution of total index values of the *Eriosema* population near Sobantu Village, Pietermaritzburg (P, *E. preptum*; H, 'intermediate plants'; C, *E. cordatum*). 8, *Sturton 1602*: putative hybrid plant between *E. cordatum* and *E. preptum*. 9, pictorialized scatter diagram of hybridizing population of *E. preptum* and *E. cordatum*, near Sobantu Village, Pietermaritzburg (sampled 1974-11-20); the terminal leaflet of the leaf subtending the second produced inflorescence was measured. 10, representative specimens of the *Eriosema* population near Sobantu Village, Pietermaritzburg: 1, *E. preptum*; 2, part of hybrid intermediate showing hybrid vigour; 3, *E. cordatum*.

can be seen that plants of *E. cordatum* mostly had longer terminal leaflets than did plants of *E. preptum*. The tendency of the hybrids to produce longer inflorescences than those of either putative parent is also apparent. What is not clearly shown is the hybrid vigour of the putative hybrids, but this may be seen in Fig 10.

The hybrid plant (half the specimen was photographed) shown in Figs 8 & 10 is a robust intermediate, and of all the different 'introgressants' is, with others like it, the least likely to be found in the proximity of either parent.

The hybrids were found scattered throughout the total population but tended to be aggregated in micro-localities not particularly favoured by either parent.

Although the overall population at Sobantu Village has been interpreted as exhibiting signs of introgressive hybridization, it is quite likely that this may be an incorrect explanation as a number of alternatives are theoretically plausible. Firstly, individuals having characters of two species may represent the remnants of the ancestral population out of which the two species differentiated (Dobzhansky, 1941). This does not appear to be the case here as the introgressants were mostly sterile and were found in the more recently disturbed areas of the total population.

A second alternative might be that the variation arose through mutation. Heiser (1973) pointed out that this is probably not uncommon and quoted Mayr (1942) as saying that it is known that the basic potentialities of related species tend to be similar and so the mutational channels are therefore more or less prescribed. This, however, also seems unlikely in view of the numbers of 'intermediates' observed.

The third possible explanation is more complex. It involves population intergradation. There are two types of intergradation. Primary intergradation (Mayr, 1942) occurs in populations that are in continuous contact, whereas secondary intergradation occurs between populations that have come together after a previous separation. Heiser (1973) pointed out that the former involved recombination and the later hybridization. Secondary intergradation could result in introgression. But as Mayr (1963) also pointed out, these two types of intergradation are not easy to distinguish, and because of this, the effects of primary intergradation would be difficult to distinguish from those of introgressive hybridization. Heiser (1973) quoted Barber & Jackson (1957) as stating that 'in a region of great ecological change one can expect simultaneous clinal variation in the frequencies of genes at a number of loci. Variability under the control of selection may reach a peak and decay on both sides of this peak'. This would lead to the loose association of variables that Anderson (1953) considered diagnostic of introgression. This would then mean that highly variable populations resulting from primary intergradation would be quite similar to those resulting from introgression. Both putative parents are widely distributed in the drier areas of Pietermaritzburg. For the most part they are allopatric but at least three localities are known where they overlap. In all the overlapping localities there is hybridization of the type reported in this section. It seems that these examples conform to Mayr's (1963) statement, that 'belts of highly variable populations in a meeting zone between rather uniform populations are almost invariably zones of secondary intergradation'.

Heiser (1973) mentioned two further possible interpretations of what is known as introgression. The first involved segmental allopolyploidy where segregates approaching one or both parents may occur. From the available cytological evidence (Baudet, 1977; Turner & Fearing, 1959), it seems that polyploidy is absent in the subtribe Cajaneae to which *Eriosema* belongs. It seems unlikely, therefore, that the intermediates of the Sobantu population were segregates produced by a polyploid species.

Heiser's second interpretation concerned the production of introgression-like effects which might result from inbreeding and selection in autogamous plants following an initial hybridization. Heiser (*l.c.*) stressed that although occasional hybridization between autogamous species did allow for the possibility of introgression, the lack of backcrossing after the initial hybridization would imply that the variation observed, while like introgression, was not the outcome of this phenomenon.

Field and laboratory experiments which involved bagging and emasculation of flowers revealed that both putative parents of the Sobantu Village population failed to set seed if the inflorescences were isolated from pollinators.

One real difficulty in interpreting the Sobantu population is that there is, as Heiser (1973) pointed out, some confusion between the definition of introgression and of hybrid swarming. Whether the Sobantu population consisted of hybrid populations out of genetic contact with the putative parents, or whether it consisted of hybrid plants repeatedly backcrossing to the parental forms clearly cannot be solved without detailed genetic experiments. The unlikely possibility also exists that the introgressants are nothing more than F_1 hybrids showing a marked degree of environmental plasticity.

3. HYBRID CATALOGUE

In the hybrid catalogue I have endeavoured to include all the putative hybrids that have been found in *Eriosema* in southern Africa (Fig. 11). This hybrid list will, I hope, encourage further studies within *Eriosema*. I hope it will also indicate to future workers that hybridization probably contributes materially to the extensive variation represented within *Eriosema* in southern Africa.

Each pair of putative parents has been named and numbered as representing a case of interspecific hybridization.

Under the numbered putative parents (for example H_1), each individual hybrid specimen known has been cited, together with its putative parents where these have been suspected. Each set of citations is followed by a general discussion.

***H1 Eriosema cordatum* E. Mey. × *E. salignum* E. Mey. (yellow-flowered form)**

LESOTHO.—2828 (Bethlehem): Malaoaneng (—CC), Dieterlen 866 (PRE); Leribe (—CC), Dieterlen 104 (PRE).

SOUTH AFRICA.—2628 (Johannesburg): Germiston (—AA), Rogers 12199e (BOL). 2732 (Umbombo): top of Pongola Poort (—CA), Stirton 506 (PRE), putative parents Stirton 503 & 507 (PRE). 2830 (Dundee): Buyahlanga Mountain, between Wasbank and Elandslaagte (—AC), Stirton 1364 (PRE), putative parents Stirton 1362 & 1363 (PRE). 2831 (Nkandla): Eshowe (—DC), Lawn 2271 (NH); Mtunzini (—DD), Stirton 417, 1271 (PRE), putative parents Stirton 414 & 419 (PRE). 2930 (Pietermaritzburg): Hilton Road (—CB), Ford s.n. (NH); Hayfields, Pietermaritzburg (—CB),

Stirton 736 (PRE), putative parents *Stirton 737* & *738* (PRE); also *Stirton 1169* (PRE), and *Stirton 1368* (PRE) with putative parents *1367* & *1369* (PRE); Voortrekker Road, Clarendon (—CB), *Stirton 1240* (PRE), putative parents *Stirton 1238* & *1239* (PRE); Baynesfield (—CB), *Stirton 704* (PRE), putative parents *Stirton 702* & *701* (PRE). 3029 (Kokstad); 2 km from Harding to Umzimkulu (—DB), *Story 646* pro parte (PRE). 3030 (Port Shepstone): Hazlewood, Umzinto (—BC), *Bajnath 418* (NU), putative parent *Bajnath 419* (NU).

Dieterlen 866, a hybrid, was the basis for the incorrect inclusion of *Eriosema parviflorum* E. Mey. in the flora of Lesotho. *Dieterlen 104* (PRE) has five specimens on the sheet but only the robust specimen is a hybrid. *Rogers 12199e* is included with uncertainty.

Putative hybrids between *E. cordatum* and *E. salignum* (yellow-flowered form) have been found over a wide range yet the plants that are of suspected hybrid progeny are everywhere remarkably uniform. No specimens have been found which might be considered backcrosses between the intermediate hybrid and either of the two putative parents.

Hybrids, in general, are not common and thus are likely to be rare in any locality. The *Stirton 736* Hayfields population, however, numbered over 20 plants spread over four hectares. Some of these plants had very large rootstocks and were considered to be at least five years old.

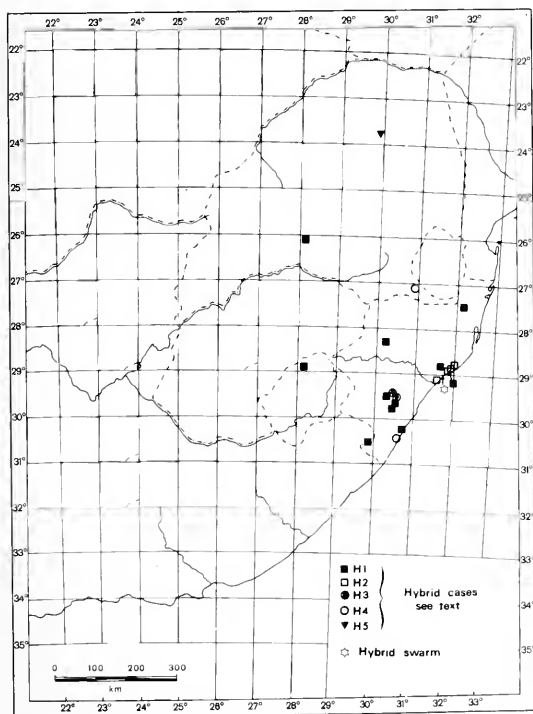


FIG. 11. — Known distribution of hybrid populations of *Eriosema* in southern Africa.

Field studies in the Hayfields population showed that *E. salignum* and *E. cordatum* usually had very little overlap in the time and duration of anthesis but on cloudy days both species showed fully reflexed flowers (i.e. flowers ready for pollination with the standard folded back) throughout the day. Sporadic hybrids were found to occur in the locality of this

population and may well have been the result of such an environmental influence. It is possible that isolating mechanisms other than time of flower reflexion may be in general operation to maintain the integrity of the two parental species. This needs further study.

Field studies during the present work have suggested that plants of *E. cordatum* and *E. salignum* hybridize more frequently than any other known cases of hybridizing species in the genus in southern Africa.

E. cordatum E. Mey. × *E. salignum* E. Mey. (yellow-flowered form) can be separated from its putative parents by the characters listed below.

<i>E. salignum</i> (yellow-flowered form)	Hybrid	<i>E. cordatum</i>
Plants erect	Plants semi-erect or ascending	Plants decumbent
Stipules becoming senescent, before young leaflets expand	Stipules senescent to halfway up stem	Stipules persistent, green
Stipules free	Stipules slightly connate at base, to $\pm \frac{1}{4}$ total length	Stipules connate, at base to $\frac{1}{4}$ total length
Under surface of leaflets woolly with longer appressed hairs on veins	Under surface of leaflets dull with semi-erect hairs on veins and in intercostal areas	Under surface of leaflets shiny with sparsely scattered erect hairs
Stem pubescence dense, appressed, finely hairy	Stem pubescence dense, shaggy and appressed.	Stem pubescence shaggy ferruginous or white, patent.
Flowers yellow	Flowers orange (or pale pink) and yellow	Flowers red and yellow

H2 *Eriosema cordatum* E. Mey. × *E. salignum* E. Mey. (red and yellow flowered form)

SOUTH AFRICA.—2831 (Nkandla): Ngoye Forest (—DD), *Stirton 1278* (PRE), putative parent *Stirton 1279* (PRE); Twinstreams Farm, Mtunzini (—DD), *Stirton 1285* (PRE), putative parents *Stirton 1283* & *1284* (PRE); University College of Zululand (—DD), *Venter 690* (ZULU), putative parent *Venter 691* (ZULU). 2930 (Pietermaritzburg; Kloof (—DD), *Galpin s.n.* (24-6-1932. BOL), mixed sheet with *E. salignum*. 2931 (Stanger); Tugela Beach (—AB), *Johnson 407* (NBG).

The suspected hybrids of putative parents *E. cordatum* and *E. salignum* (red and yellow-flowered form) are different from those cited under Case H1.



FIG. 12.—Rootsystems of 1, *Eriosema salignum*; 2, hybrid *E. cordatum* × *E. salignum*; 3, *E. cordatum*.

This evidence suggests that there may be two distinct taxa presently included in *E. salignum* and this probability is still being investigated. Case H2 hybrids are more erect with very dark green shiny upper leaf surfaces and have ovate leaflets with the bases cordate. The leaflets of Case H2 hybrids are more commonly unifoliate than in the Case H1 hybrids.

The hybrid situation on Mr I. Garland's farm at Mtunzini was particularly interesting. The hybrids were numerous and occurred wherever the putative parents were sympatric. There was a very large hybrid population at the bottom of the front lawn of his house. The hybrids were intermediate in nearly all characters, the most striking being the intermediate root system (Fig. 12). In this figure, the hybrid plant lies between the two putative parents: it can be seen to have features both of the straight daucate rootstock of *E. cordatum* and of the constricted rootstock of *E. salignum*. (Intermediate rooting systems are very characteristic of hybrids in the genus as a whole.) There was a marked hybrid vigour in this Mtunzini population. The hybrids were tall, suberect or ascending and stood out against other plants of the population.

H3 *Eriosema cordatum* E. Mey. × *E. preptum* C. H. Stirton

SOUTH AFRICA.—2930 (Pietermaritzburg): Hilton College farm-lands (—CB), *Khan s.n.* (NU 45857); behind S.P.C.A. kennels, Scottsville, Pietermaritzburg (—CB), *Stirton* 713 (PRE, this is a mixed collection containing both putative parents) and *Stirton* 1243 (PRE), putative parents *Stirton* 1241 & 1242 (PRE); near Sobantu Village (—CB), *Stirton* 1411 (PRE), putative parents *Stirton* 1409 & 1410 (PRE).

The *Stirton* 1409–1411 population was analysed under Introgressive Hybridization. In the Sobantu Village and Scottsville populations there was marked hybrid vigour and an intermediate type of rooting system. The main differences between the hybrids and the putative parents are summarized below. It must be stressed, however, that in dealing with an introgressed population the choice of characters are to some extent arbitrary. Overlap must therefore be expected.

<i>E. cordatum</i>	Hybrid	<i>E. preptum</i>
Plants prostrate	Plants semi-erect or ascending, very robust	Plants erect
Stem vesture consisting of stiff, spreading, ferruginous hairs	Stem vesture consisting of short white hairs with spreading yellow hairs interspersed	Stem vesture consisting of short white hairs with longer appressed white hairs interspersed
Under surface of leaflets shiny with white glands and scattered erect hairs interspersed	Under surface of leaflets either sparsely woolly with longer erect hairs and yellow glands interspersed or dull with orange glands and scattered erect hairs interspersed	Under surface of leaflets dense white woolly with longer appressed hairs on the veins. Yellow glands interspersed
White glands on calyx	Orange glands on calyx.	Yellow glands on calyx.
Rootstock carrot-like with occasional right-angled extensions; short stylopodium	Long central carrot-like rootstock often very thick and constricted with or without numerous small beaded off-shoots.	Rootstock with long stylopodium: thin and beaded when young but tending towards slightly wavy or constricted but carrot-like when old
Flowers red and yellow	Flowers pink, orange and yellow	Flowers orange with red veins, or yellow-orange

H4 *Eriosema cordatum* E. Mey. × *E. kraussianum* Meisn.

SOUTH AFRICA.—2730 (Vryheid): 18 km from Vryheid to Paulpietersburg (—DB), *Stirton* 1323 (PRE), putative parent *Stirton* 1324 (PRE), *E. kraussianum* seen but not collected). 3030 (Port Shepstone): Turnoff to Greenhart on Port Shepstone Road (—DD), *Stirton* 1402, 1405 (PRE), putative parents *Stirton* 1403, 1404 (PRE).

The *Stirton* 1402–1405 population shows characteristics associated with introgression. Two clear-cut intermediates were noted in the field. *Stirton* 1402 showed hybrid vigour and was morphologically close to *E. cordatum*, whereas *Stirton* 1405 was a stunted, multistemmed plant approximating *E. kraussianum*. The first plants that I found on locating the population were 'introgressants' that I was unable to relate to any species. They grew in deep sand along a road. After studying them for some time two factors drew my attention, namely, their pinkish flowers, and their abortive or irregular seed set. The overall facies of these plants led me to postulate that they were hybrids and that one of the putative parents was *E. cordatum*. After a search down the left-hand side of the road I found a large colony of *E. cordatum* growing on a sandy bank near the end of the road, about 500 m from the first 'introgressants'. I returned down the opposite side and discovered a strange collection of very stunted plants that gave an immediate impression of *E. kraussianum*. These orange and yellow-flowered plants were growing on the damp sandy lip of an irrigation canal. After further searching I found a small colony of *E. kraussianum* within the same general locality. In trying to reconstruct how the various plants became distributed, I noticed that the soils of the two hybrid colonies had been removed from the general vicinity of the parental populations during road-building operations. The two hybrid colonies were established in local habitats that were different in both water availability and aspect. It was possible that the hybrids had resulted from seed or roots being transported in the sand. If putative parents had also been transported, it could be that these were unable to survive the harsher environmental conditions of the hybrid localities.

The second example, *Stirton* 1323, was an isolated plant growing in a very disturbed intermediate habitat. It had numerous ascending to erect stems and showed marked hybrid vigour.

H5 *Eriosema transvaalense* C. H. Stirton × *E. angustifolium* Burt Davy

SOUTH AFRICA.—2329 (Pietersburg): near the Magoebaskloof Hotel, (—DB), *Stirton* 1442a, 1442b, putative parents *Stirton* 1445 & 1444 (PRE).

The facies of the *Stirton* 1442–1445 population is similar in many ways to that described for the *Stirton* 1409–1411 population of *E. cordatum* E. Mey. × *E. preptum* C. H. Stirton. In both instances the habitat had been subjected in the past to burning. The soil cover and type was also rather variable. *Stirton* 1442a (sheet 1) showed the greatest hybrid vigour. This population may be backcrossing to either parent as *Stirton* 1442a (sheet 2) and *Stirton* 1442b were intermediates between *Stirton* 1442a (sheet 1) and *E. transvaalense* (*Stirton* 1445) and *E. angustifolium* (*Stirton* 1444) respectively. The hybrids were spread randomly throughout the population and were readily distinguishable on habit and flower colour. *E. transvaalense* has pink and yellow flowers and is a prostrate, softly pubescent densely matted plant whereas *E. angustifolium* is an erect, stiffly haired yellow-flowered species. The hybrids tended to have

pale pink flowers and to vary from prostrate, ascending to erect in habit.

E. transvaalense and *E. angustifolium* are sympatric species but this small population is the only one in which I have found hybridization between the two species.

H6 Hybrid swarm

SOUTH AFRICA.—2931 (Stanger): 1 km past Gingindlovu to Durban (—BA), *Stirton 1259, 1260* (PRE), putative parents *E. salignum* [*Stirton 1257* (PRE)], *E. psoraloides* [*Stirton 1258* (PRE)], *E. cordatum* [*Stirton 1261* (PRE)] and *E. preptum* [*Stirton 1262* (PRE)].

This population was spread over a disturbed, recently-felled *Eucalyptus* plantation. *Stirton 1259* had yellow flowers and was semi-erect, whereas *Stirton 1260* was pale pink-flowered, numerous stemmed and prostrate. These two collections formed the limits of the range of variation. There was a wide range of 'intermediates' between the four 'putative' parents. I attempted to analyse this population using the techniques described earlier but could not make any sense of the results. As there was no time available to pursue the problem it is reported here in case difficulties may be encountered in identifying plants collected in the Gingindlovu area.

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The bulk of this study was undertaken in 1974 as part of a Masters thesis at the University of Natal, Pietermaritzburg. I am grateful to the former Head of Department of Botany, Professor C. H. Bornman, and his staff for facilities and assistance; to the Secretary of the Department of Agricultural Technical Services and the Director, Botanical Research Institute for one year's study leave; to L. Cowan for Figs 5 & 8 and for assistance in the field, and finally to Professor K. D. Gordon-Gray for her enthusiastic supervision and inspiring introduction to biosystematic botany.

UITTREKSEL

Beide spontane en introgressiewe verbastering kom in die natuur in Eriosema in Suid-Afrika voor. Daar word verslag gegee van een geval van hibriede-geswerm en 'n lys van ses hibriede word aangebied en tot in besonderhede bespreek.

REFERENCES

- ADAMS, R. & TURNER, B., 1970. Natural populations of *Juniperus ashei* Buch. *Taxon* 19: 728–751.
- ALSTON, R. E., 1959. Application of paper chromatography to systematics: recombination of parental biochemical components in a *Baptisia* hybrid population. *Nature* 184: 285–286.
- ALSTON, R. E., TURNER, B. L., LESTER, R. N. & HORNE, D., 1962. Chromatographic validation of two morphologically similar hybrids of different origins. *Science* 137: 1048–1050.
- ALSTON, R. E. & TURNER, B. L., 1963. Natural hybridization among four species of *Baptisia* (Leguminosae). *Amer. J. Bot.* 50: 159–173.
- ALSTON, R. E. & HEMPEL, K., 1964. Chemical documentation of interspecific hybridization. *J. Hered.* 55: 267–269.
- ALSTON, R. E., 1965. Flavonoid chemistry of *Baptisia*: a current evaluation of chemical methods in the analysis of interspecific hybrids. *Taxon* 14, 8: 268–274.
- ANDERSON, R. C. & HARRISON, T., 1979. A limitation of the hybrid index using *Quercus* leaf characters. *Southwest. nat.* 24, 3: 463–473.
- ANDERSON, E., 1949. *Introgressive hybridization*. London: Wiley. 109 pp.
- ANDERSON, E., 1953. Introgressive hybridization. *Biol. Rev.* 28: 280–307.
- ANDERSON, E., 1956. Natural history, statistics and applied mathematics. *Amer. J. Bot.* 43: 883–889.
- ANDERSON, E., 1957. A semigraphical method for the analysis of complex problems. *Proc. Natn. Acad. Sci. (U.S.A.)* 43: 923–927.
- BARBER, H. & JACKSON, W., 1957. Natural hybridization in action in *Eucalyptus*. *Nature, Lond.* 1979: 1267–1269.
- BAUDET, J., 1977. Recherches sur la classification generique des papilionaceae — Phaseoleae. Ph. D. thesis, University Pierre & Marie Curie, Paris 213 pp.
- DOBZHANSKY, T., 1941. *Genetics and the origin of species*. New York: Columbia University Press. 446 pp.
- FLAKE, R., RUDLOFF, E. & TURNER, B., 1969. Quantitative study of clinal variation in *Juniperus virginiana* using terpenoid data. *Proc. Nat. Acad. Sci. (U.S.A.)* 64: 487–494.
- GRANT, V., 1971. *Plant speciation*. New York: Columbia University Press. 435 pp.
- GRANT, V., 1979. Character coherence in natural hybrid populations in plants. *Bot. Gaz.* 140, 4: 443–448.
- GRANT, V., 1975. *Genetics of flowering plants*. New York, Columbia University Press.
- HATHEWAY, W. H., 1962. Natural hybridization between *Phlox maculata* and *Phlox glaberrima* and its evolutionary significance. *Amer. J. Bot.* 50: 714–720.
- HEISER, C. B., 1973. Introgression re-examined. *Bot. Rev.* 39, 4: 347–366.
- HILLIARD, O. & BURTT, B., 1971. *Streptocarpus: an African plant study*. Pietermaritzburg: University of Natal Press. 410 pp.
- LEVIN, D. A., 1967. Hybridization between annual species of phlox: population structure. *Amer. J. Bot.* 59, 9: 1122–1130.
- MAYR, E., 1942. *Systematics and the origin of species*. New York: Columbia University Press. 334 pp.
- MAYR, E., 1963. *Animal species and evolution*. Cambridge: Belknap Press. 797 pp.
- SIBLEY, C. G., 1957. The evolutionary and taxonomic significance of sexual dimorphism and hybridization in birds. *Condor* 59: 166–191.
- SOLBRIG, O. T., 1970. *Principles and methods of plant biosystematics*. London: Macmillan. 226 pp.
- TURNER, B. L. & FEARING, O. S., 1959. Chromosome numbers in the Leguminosae: African Species, including phyletic interpretations. *Amer. J. Bot.* 46, 1: 49–57.
- WELLS, H., 1980. A distance coefficient as a hybridization index: An example using *Mimulus longiflorus* and *M. fleningsii* (Scrophulariaceae) from Santa Cruz Island, California. *Taxon* 29: 53–65.

Studies in the Leguminosae—Papilionoideae of southern Africa

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ABSTRACT

Six African species of *Psoralea* are transferred to *Cullen* Medik.: *C. biflora* (Harv.) C. H. Stirton, *C. holubii* (Burt Davy) C. H. Stirton, *C. drupacea* (Bunge) C. H. Stirton, *C. jaubertiana* (Fenzl) C. H. Stirton, *C. obtusifolia* (DC.) C. H. Stirton and *C. plicata* (Del.) C. H. Stirton. *Psoralea patersoniae* Schönl. based on an introduced garden plant is placed under synonymy of *Cullen corylifolia* (L.) Medik. The following new names are published: *Lebeckia waltersii* C. H. Stirton of subgenus *Plecolobium* C. H. Stirton; *Bituminaria bituminosa* (L.) C. H. Stirton of subgenus *Bituminaria* and *B. acaulis* (Stev.) C. H. Stirton of subgenus *Christevenia* Barneby ex C. H. Stirton; *Rhynchosia arida* C. H. Stirton; *Eriosema gunniae* C. H. Stirton, *E. preptum* C. H. Stirton and *E. transvaalense* C. H. Stirton. *Eriosema capitatum* E. Mey. is placed in synonymy with *Psoralea tomentosa* Thunb., but as *P. tomentosa* Thunb. is a later homonym of *P. tomentosa* Cav. it should be referred to *P. sericea* Poir.

RÉSUMÉ

ÉTUDES SUR LES LEGUMINOSAE-PAPILIONOIDEAE D'AFRIQUE AUSTRALE

Six espèces africaines de *Psoralea* sont transférées à *Cullen* Medik.: *C. biflora* (Harv.) C. H. Stirton, *C. holubii* (Burt Davy) C. H. Stirton, *C. drupacea* (Bunge) C. H. Stirton, *C. jaubertiana* (Fenzl) C. H. Stirton, *C. obtusifolia* (DC.) C. H. Stirton et *C. plicata* (Del.) C. H. Stirton. *Psoralea patersoniae* Schönl. basée sur une plante de jardin introduite est placée sous la synonymie de *Cullen corylifolia* (L.) Medik. Les nouveaux noms suivants sont publiés: *Lebeckia waltersii* C. H. Stirton et du sous-genre *Plecolobium* C. H. Stirton, *Bituminaria bituminosa* (L.) C. H. Stirton du sous-genre *Bituminaria* et *B. acaulis* (Stev.) C. H. Stirton du sous-genre *Christevenia* Barneby ex C. H. Stirton; *Rhynchosia arida* C. H. Stirton, *Eriosema gunniae* C. H. Stirton, *E. preptum* C. H. Stirton et *E. transvaalense* C. H. Stirton. *Eriosema capitatum* E. Mey. est placé en synonymie avec *Psoralea tomentosa* Thunb., mais comme *P. tomentosa* Thunb. est un dernier homonyme de *P. tomentosa* Cav. il devrait se référer à *P. sericea* Poir.

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1. *Cullen* Medik.
2. *Bituminaria* Heist. ex Fabricius
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6. *Eriosema* (DC.) G. Don

INTRODUCTION

This paper is the first in a series of notes on the taxonomy of the Leguminosae — Papilionoideae for the Flora of Southern Africa series. Included also are nomenclatural changes that appertain to floras lying beyond this area.

1. CULLEN Medik.

Recent investigations have shown that the South African representatives of *Psoralea* L. sensu Forbes (1930) should be rearranged into the genera *Psoralea* L., *Otholobium* C. H. Stirton and *Cullen* Medik. (Stirton, 1980). *Psoralea* L. emend. C. H. Stirton is now restricted to 17 Cape species. The new genus *Otholobium* comprises about 28 species widespread over the southern and eastern parts of southern Africa, with one species extending as far north as Kenya. New combinations will be made in *Otholobium* once the complicated nomenclatural problems have been resolved. The remaining seven African species of *Psoralea* L. sensu Hutch. are here transferred to *Cullen* Medik. The Asian and Australasian material of *Cullen*, comprising over 40 species, falls outside the scope of this investigation.

1. *Cullen biflora* (Harv.) C. H. Stirton, comb. nov.

Psoralea biflora Harv., Fl. Cap. 2: 157 (1862). Type: South Africa, Burchell 1720 (K, holo.!).

2. *Cullen corylifolia* (L.) Medik. in Vorles, Churpf. Phys.-Oek. Ges. 2: 380 (1787).

Psoralea corylifolia L. Sp. Pl. 764 (1753). Type: India, Herb. Linn. 928. 24 (LINN, holo.!).

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Psoralea patersoniae Schönl. in Rec. Albany Mus. 3:54 (1914). Type: South Africa, Redhouse, Paterson 383 (K, holo.!) syn. nov.

3. *Cullen drupacea* (Bunge) C. H. Stirton, comb. nov.

Psoralea drupacea Bunge in Arb. Nat. Ver. Riga 221 (1847). Type: U.S.S.R., between Buchara and Samarkand, Lehmann s.n. (LÉ, not seen).

4. *Cullen holubii* (Burt Davy) C. H. Stirton, comb. nov.

Psoralea holubii Burt Davy, Fl. Transv. 2: XXIX (1932). Type: South Africa, Matebe, Holub s.n. (K, holo.!).

5. *Cullen jaubertiana* (Fenzl) C. H. Stirton, comb. nov.

Psoralea jaubertiana Fenzl in Flora 26: 392 (1843). Type: Syria, between Aleppo and Orfar, Kotschy (not seen).

6. *Cullen obtusifolia* (DC.) C. H. Stirton, comb. nov.

Psoralea obtusifolia DC., Prodr. 2: 221 (1825). Type: South Africa, Burchell 1214 (P, holo.!: K, iso.!).

7. *Cullen plicata* (Del.) C. H. Stirton, comb. nov.

Psoralea plicata Del., Fl. Egypt. 252, t. 27, fig. 3 (1812). Type: between Qournah and Medynetabou, Delile s.n. (MPU, not seen).

Psoralea odorata Blatt. & Halb. in J. Bombay nat. Hist. Soc. 26: 238 (1918). Type: India, Jodhpore, Barmer, Blatter 7005 (K, holo., photo.!).

2. BITUMINARIA Heist. ex Fabricius

Psoralea bituminosa L. and *P. acaulis* Stev. are two widely cultivated species of *Psoralea* L. sensu lato. The recent decision to confirm the subdivision

of *Psoralea* L. into a number of genera (Stirton, 1980) has made it necessary to search for a generic name to accommodate them, the name *Psoralea* now being reserved for some 17 species of plants endemic to the southern tip of Africa. Most authors have used *Aspalathium* Medik (1787) as a segregant generic name to accommodate *P. bituminosa* whenever it was thought to be distinct from *Psoralea* (e.g. Meikle 1977). According to Dandy (1967), however, the name *Bituminaria* Heist. ex Fabricius (1759) is a synonym of *Psoralea* sensu lato. It predates *Aspalathium* and becomes available. There is however some controversy about selecting Fabricius generic names based on Heister's works. Some authors such as Holub (1970) and Rauschert (1968) consider Fabricius's generic names to be uninomials and invalidly published. Dandy (1967) and Stafleu & Cowan (1976) disagree with this considering that the typographical distinction of the uninomials clearly distinguishes them as generic names. Fabricius (Enum., 1759), however, consistently distinguishes generic names by capitals. After consulting Dr R. K. Brummitt and Mr R. D. Meikle (Royal Botanic Gardens, Kew) and in view of the conservation of a number of Fabricius's names, I have accepted that *Bituminaria* Heist. ex Fabricius, as the protologue shows, is validly published.

'BITUMINARIA Heister. Trifolium asphaltites f. bituminosum Rpp. & Dod. *Psoralea* Linn. Planta fere arboreus. Flores spicati pediculis communi longo sustinentur, 3. foliolis in 3. vel. 4 lacinias dissectis 3. utpl. flores ex ala sua emittentibus petiolatos. Perianthum tubulosum quinquefidum, una lacinia maxima. Vexillum purpureo violaceum oblongum sursum et ad latera reflexum in medio faciei internae 2. appendiculis instructum. Alae breviores albae rectae concavae. Carina brevior purpurea anterior, postgrae alba obtusa bipetala, reliqua ut in alia trifoliis. Sed fructus sit. legumen compressum rotundo falcatum setosum ultra perianthium prominens, et continens semen unicum magnum figura phaseoli'.

Bituminaria Heist. ex Fabricius comprises two species and is closely related to or may be congeneric with *Pedimelum* Rydb. from North America. Pending further study which may indicate otherwise, I recognize two distinct subgenera: *Bituminaria* and *Christevenia* Barneby ex C. H. Stirton.

***Bituminaria* Heist. ex Fabricius, Enum. 165 (1759); Dandy, Regn. Veget. (1967). Type species: *Bituminaria bituminosa* (L.) C. H. Stirton.**

Psoralea L., Sp. Pl. 1: 762 (1753), pro parte.

Aspalathium Medik. Vorles. in Churpf. Phys.-Oek. Ges. 2: 380 (1787).

Key to subgenera

Plant caulescent; leaflets entire; peduncles axillary (Mediterranean Europe and Macaronesia) . . . subgen. *Bituminaria*
Plant acaulescent from superficial caudex; leaflets denticulate; peduncles scapiform (north-eastern Turkey and W. Transcaucasus) . . . subgen. *Christevenia*

Subgen. *Bituminaria*

Plant perennial, caulescent. *Leaves* pinnately trifoliolate, entire. *Flowers* shortly spicate on elongated axillary peduncles; bracts at each node of the inflorescence united through half their length or more, those at the lower nodes into a flabellate 3(5)-toothed blade, succeeding ones often narrower or the uppermost wanting; calyx ebracteolate. *Fruit* indehiscent, with a long sword-shaped beak which at length breaks off, furnished with glabrous spinulose processes; pericarp adnate to seed.

The single species in this subgenus, *B. bituminosa*, is very distinct yet remarkably variable throughout its range. It has been widely cultivated throughout Europe and to a lesser extent elsewhere. A survey of the available material would indicate that it comprises a number of distinct taxa, some of which are quite localized. This subgenus needs to be investigated anew over its entire range. Particular attention should be paid to floral dissections. *Psoralea morisiana* Pignatti & Metlesics belongs here and may be quite a distinct species. Its status will have to be determined in context of the overall range of *B. bituminosa* (see: Bol. Soc. Sarda Sci. Nat. 15: 53, 1975).

1. *Bituminaria bituminosa* (L.) C. H. Stirton, comb. nov. Type: in Siciliae, Italiae, Narbonae colibus maritimis.

Psoralea bituminosa L., Sp. Pl. 1: 763 (1753); Boiss., Fl. Or., 2: 187 (1872); Stuart Thompson in J. Bot., Lond. 44: 306 (1906); Post, Fl. Palest., ed. 2, 1: 367 (1932); Davis, Fl. Turkey, 3: 264 (1970); Zohary, Fl. Palest., 2: 50, t. 66 (1972).

Aspalathium frutescens Medik. in Vorles. Churpf. Phys.-Oek. Ges., 2: 380 (1787); *Aspalathium herbaceum* Medik., l.c. 2: 381 (1787). *Aspalathium bituminosum* (L.) Fourr. in Ann. Soc. Linn. Lyon, ser. 2, 16: 365 (1868); Kuntze in Post & Kuntze, Lex. Gen. Phan., 48 (1903) as *Aspalathium bituminosum*; Meikle, Fl. Cyprus, 1: 489 (1977).

Subgen. *Christevenia* Barneby ex C. H. Stirton, subgen. nov.

Planta perennis, acaulis. *Folia* subdigitatim trifoliolata, denticulata. *Flores* capitati, pedunculo elongato scapiformi; bracteae in quoque nodo inflorescentiae usque ad basin distinctae; calyx basi untrinque bracteola lineari instructus. *Fructus* indehiscent, rostro ensiformi processibus mollibus pubescentibus armato.

Type species: *Bituminaria acaulis* (Stev.) C. H. Stirton.

Plant perennial, acaulescent. *Leaves* subdigitately trifoliolate, denticulate. *Flowers* capitate on elongated scapiform peduncles; bracts at each node of the inflorescence separate to the base; calyx furnished at the base, each side with a linear bracteole. *Fruit* indehiscent, with a sword-shaped beak armed with soft pubescent processes.

The single species in this subgenus, *B. acaulis* (Stev.) C. H. Stirton, occurs in north-eastern Turkey and the west Transcaucasus.

2. *Bituminaria acaulis* (Stev.) C. H. Stirton, comb. nov. Type: in iberia occidentali (W. Georgia).

Psoralea acaulis Stev. ap. Hoffm. in Comm. Soc. Phys.-mat. Mosq. 1: 47 (1806); M. B. Fl. taur.-Cauc. 2: 206 (1808); Ldb., Fl. Ross. 1: 563 (1842); Boiss., Fl. Or. 2: 187 (1872); Grossg., Fl. Kavk. 2: 291 (1930); Vasil'chenko in Fl. U.S.S.R. 11: 226 (1945), Eng. transl. 1971; Davis., Fl. Turkey 3: 264 (1970). *Aspalathium acaulis* (Stev.) Hutch., Gen. Fl. Pl. 1: 420 (1964).

3. *LEBECKIA* Thunb.

For a number of years an undescribed Cape legume has been circulating under the manuscript name '*Waltersia heleniae*'. The correct generic placement of this undescribed species has remained unresolved ever since it was first discovered and collected by Dr I. B. Walters. It had been variously referred to *Buchenroedera*, *Wiborgia* and *Lebeckia*. Apart from the collections cited and the one in Dr Walters's per-

sonal herbarium, this species has apparently not been collected by the early collectors. This seems surprising considering the plant's rather distinctive features and, so, notwithstanding its localized distribution, it is to be expected that additional collections may still be found misfiled in undetermined covers among various genera. I have referred it to *Lebeckia* notwithstanding the un-*Lebeckia* like presence of prominent involucre stipules. The only other legume in South Africa which I know to have similar stipules is *Argyrolobium involucreatum*. The alternative is to describe a new monotypic genus. Such an approach would be somewhat premature until *Lebeckia* and its segregates have been adequately revised and until more is known about this species which I am describing as *Lebeckia waltersii*. This species is easily separated from all other *Lebeckia* species by its unique stipules and plicate pods. I am therefore establishing the subgenus *Plecolobium* to accommodate it. This name refers to the concertina-like pods.

Subgen. *Plecolobium* C. H. Stirton, subgen. nov.

Frutices parvi valde ramosi, stipulis conferruminatis petiolo adnatis ramulos omnino vaginantibus. Fructus plicati, indehiscentes, modice lignosi.

Type species: *Lebeckia waltersii* C. H. Stirton.

Small profusely branched shrubs with fused stipules adnate to the petiole and completely sheathing the branches. Fruits indehiscent, plicate, somewhat woody.

Lebeckia waltersii C. H. Stirton, sp. nov., affinitate incerta.

Frutex erectus ramosissimus 50–60 cm altus. Stipulae conferruminatae petiolo adnatae, ramulos omnino vaginantes. Folia trifoliolata, argentea; foliola 4–10 mm longa, usque 2 mm lata, subsessilia, aequalia, anguste obovata, curvata, conduplicata. Inflorescentia 1–3-flora, axillaris. Flores 10 mm longi, pedicello 3–5 mm longo. Calycis dentes tubo breviores, lobis vexillaribus maxime fissis, tenuiter pubescentes. Vexillum 8,6 mm longum, usque 9,5 mm latum, unguiculatum, dorso sericeum. Petala alaria carinalibus subaequilonga. Pistillum 10–11-ovulatum; ovarium sericeum. Stamina monodelpha, axialiter usque ad basin fissa, antheris dimorphis. Stigma minutum. Fructus plicatus. Semina reniformia, late brunnea.

TYPE.—CAPE, 3319 (Worcester): Worcester Com-mage (—CB), Rourke 1484 (K, holo.!).

Erect much-branched shrub 50–70 cm high. Stipules fused and wholly adnate to the petiole and completely sheathing branches, becoming bifurcate in leaves that subtend inflorescences, sericeous. Leaves trifoliolate, very shortly petiolate. Leaflets 4–10 mm long, 1,5–2,0 mm wide, subsessile, equal in size, narrowly obovate, somewhat recurved, base cuneate, apex obtuse, conduplicate, rarely flattened, sericeous. Inflorescences axillary, 1–3-flowered, borne on short lateral branches. Flowers 10 mm long, bright yellow (less yellow than in *L. cytisoides*, however), each subtended by a very small erect bract, ebracteolate; pedicel 3–5 mm long. Calyx 4 mm long; triangular teeth shorter than the 3 mm tube, vexillar lobes less connate than lateral and keel lobes; finely pubescent outside, glabrous inside. Standard 8,5 mm long, up to 9,5 mm wide, claw 3 mm long, broadly ovate, auricles and appendages absent, apex emarginate, back silky. Wing petals 10,5 mm long, 4,0 mm wide, claw 3 mm long, cultrate, sparsely pubes-

cent, equal in length to keel; sculpturing upper basal and left central, finely lamellate-lunate; auriculate. Keel petals fused, 9,5 mm long, 3,5 mm wide, somewhat pubescent. Pistil 7–8 mm long; ovary 5 mm long, subsessile, flattened and most hairy above and below, sparsely laterally style erect, glabrous, height of curvature 2,5–3,0 mm; stigma minute, very finely penicillate. Stamens monadelphous, sheath split adaxially; anthers dimorphic, basifixed anthers narrowly ovate and 2,5 mm long, dorsifixed anthers rounded and 1,3 mm long. Fruit 15–20 mm long, 4–5 mm wide, plicate, indehiscent, somewhat woody, persisting on the plant for more than a year. Seeds 3 mm wide and long, reniform, greenish brown. $2n = 32$ (count by Christine Brighton, Jodrell Laboratories, Kew). Fig. 1.

Lebeckia waltersii is endemic to the south-western Cape (Fig. 2) and is found growing in renosterbosveld on Table mountain sandstone conglomerate in association with *Pteronia* and *Elytropappus*. Flowering occurs in July.

HERB. HORT. KEW



KEW NEGATIVE
NO. 19290
-5 DEC 1974

HERB. HORT. KEW, BOT. KEW, SHEET 7/5
FLORA OF SOUTH AFRICA

Name
Voucher No.
Locality: CAPE, Worcester, Worcester Com-mage
Date of Spec. Recd. at KEW: 1974
Herb. No. 7-1975
Number 1484
Notes: Growing in renosterbosveld on Table mountain
in W. Rourke's collection. Found by Walter S. Walters
in 1974. Plants yellow, under 10 cm. Branches
collected by P. Rourke Nov. 1974

FIG. 1.—*Lebeckia waltersii*. Rourke 1484, holotype in K.

CAPE.—3319 (Worcester): Worcester (—CB), Rourke 1484 (K; NBG; PRE); Esterhuysen 35048 (K; BOL); Walters s.n. (NBG, Herb. Walters).

Hutchinson 253 (K) collected between Vredenburg and Hoetjies Bay may be conspecific with *Lebeckia waltersii*. It may even represent another species. It has overall a similar appearance to Rourke 1484 but differs in its non-conduplicate, wider leaves, more than 1-flowered inflorescence, less prominent stipule

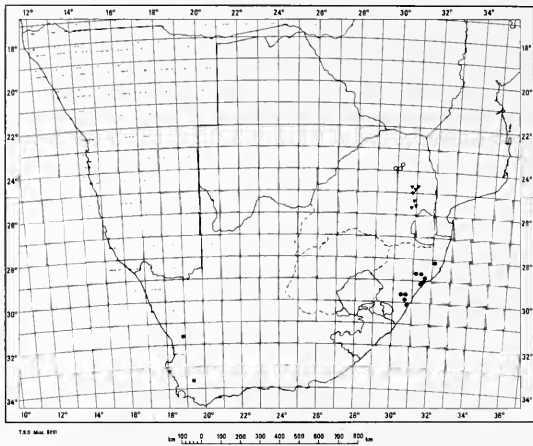


FIG. 2.—Known distribution in southern Africa of *Lebeckia waltersii* (■), *Rhynchosia arida* (★), *Eriosema gunnii* (▼), *E. preptum* (●) and *E. transvaalense* (○).

scars and disjunct distribution. I have included it tentatively under *L. waltersii* as it fits nowhere else. It had been incorrectly named *Wiborgia sericea* Thunb. *Hutchinson* 253 is without fruits, which are required for a firm decision. I have seen no further collections of it.

L. waltersii is an attractive shrub which, with its mass bloom of small yellow flowers, should delight gardeners. There is a very real danger however that this species may become extinct unless the citizens of Worcester, its locality, take concerted action to ensure its protection. It is limited to probably only some ± 60 individual plants divided into a few colonies (Walters, 1980, pers. comm.) Perhaps Worcester could adopt it as their town flower? If other towns and villages throughout the country similarly adopted a rare or endangered species specific to their area perhaps much could be done to ensure the adequate protection and propagation of many species of plants across the length and breadth of South Africa.

The specific epithet *waltersii* is given in recognition of the determined campaign that Dr I. B. Walters of Worcester has waged in ensuring that *L. waltersii* was at least named before it disappeared! It is now up to the citizens of Worcester.

4. RHYNCHOSIA Lour.

Rhynchosia arida C. H. Stirton, sp. nov., affinitate incerta.

Frutex deciduus usque 1 m altus et latus verne florens; ramuli virgati, puberuli et sparsim glandulosi. Folia trifoliolata; foliola ovata vel elliptica, apice uncinata, basi truncata, 10–20 mm longa, 9–13 mm lata, atrovirentia; lateralibus inaequalia, basi obliqua, terminali symmetrico breviora; supra puberula, infra glabrescentia, in utroque superficie glandulosa. Stipulae subulatae, glandulosae. Petioli 9–13 mm longi. Racemi axillares, 2–4-flori, foliis longiores; pedunculus 13–20 mm longus. Flores lutescentes, 14–16 mm longi; bractea 4–5 mm longa, caduca, leviter navicularis. Calyx 15–16 mm longus, inaequaliter lobatus, sparsim pilosus, glandulis magnis basi bulbosis conspicue tectus; tubus 5 mm longus; lobus carinalis ceteris longior, lanceolatus, acuminatus; lobi laterales falcati; lobi cornuti per dimidium longitudinis conferruminati. Vexillum unguiculatum, 11–12 mm longum, 10 mm latum,

late ovatum, glabrum et eglandulosum, vix reflexum, carina brevius sed alis longius, callis leviter evolutis et bene supra parvas auriculas sitis. Alae glabrae, 10–11 mm longae, carina breviores, marsupio evoluti, auricula bene evoluta, sculptura secus cristam marsupii leviter evoluta, lamellatae. Carina glabra, laminis 13 mm longis, usque 7–8 mm latis, basi curvatis, apice obtusis, marsupioevoluto. Vagina staminalis 12–13 mm longa, stamine discreto 14 mm longo, antheris uniformibus, filamentorum breviorum medifixis, longiorum basifixis, dehiscencia longitudinali. Gynoecium 13 mm longum, ovarium 4 mm longum, cum gyophoro 1 mm longo; pubescentia brevi, patente; curvatura 5 mm alta; stigma capitatum, ultra stamina exsertum. Nectarium 0.4–0.6 mm altum, margine undulato. Legumina 3–4 cm longa, 1 cm lata, falcata, lignosa, margine undulato, subtiliter pubescente. Semina ignota.

TYPE.—Cape, 3118 (Vanrhynsdorp), Mount Matsikamma (–DB), *Acocks* 15125 (K, holo.; PRE, iso.!).

Deciduous shrub up to 1 m high and broad, flowering in spring; branchlets virgate, puberulous and sparsely glandular. Leaves trifoliolate; leaflets ovate or elliptic, apex uncinata, base truncate, 10–20 mm long, 9–13 mm wide, dark green; laterals unequal-sided, oblique at base, smaller than symmetrical terminal leaflet; puberulous above, glabrescent below, glandular on both surfaces. Stipules subulate, glandular hairy. Petioles 9–13 mm long. Racemes axillary, 2–4-flowered, longer than leaves, peduncle 13–20 mm long. Flowers yellow, 14–16 mm long; bracts 4–5 mm long, caducous, slightly boat-shaped. Calyx 15–16 mm long, unequally lobed, sparsely pilose, conspicuously covered with large bulbous-based glands; tube 5 mm long; keel lobe longest, lanceolate, acuminate, laterals falcate, vexillar lobes fused for half their length. Standard unguiculate, 11–12 mm long, 10 mm wide, broadly ovate, glabrous, eglandular, scarcely reflexed, shorter than keel but longer than wings, appendages weakly developed and situated well above small auricles. Wings 10–11 mm long, glabrous, shorter than keel, pocket present, auricle well developed, sculpturing weakly developed along ridge of pocket, lamellate. Keel blades 13 mm long, 7–8 mm wide at maximum, glabrous, incurved, apex obtuse, pocket present. Staminal sheath 12–13 mm long, free stamen 14 mm long, anthers uniform, medifixed and basifix, dehiscence longitudinal. Gynoecium 13 mm long, ovary 4 mm long with gynophore 1 mm long; clothed with short patent pubescence; curvature 5 mm high; stigma capitate, exerted beyond stamens. Nectary 0.4–0.6 mm high, margin undulate. Fruits 3–4 cm long, 1 cm wide, falcate, woody, upper margin undulate, finely pubescent. Seed unknown. Fig. 3.

It is now over thirty years since the first and only specimen of this species was collected in semi-succulent karoo along the lower slopes of Mt Matsikamma (Fig. 2). *R. schlechteri* Bak., *R. bullata* Benth. ex Harv., *R. ferulaefolia* Benth. ex Harv., *R. pinnata* Harv. and *R. viscidula* Steud. are the only species of *Rhynchosia* that are distributed in Mediterranean areas of the Cape and are therefore outliers in an essentially subtropical genus. These rare, unrelated species, including *R. arida*, are endemic to the Cape. All have narrow disjunct distributions with few relatives elsewhere in the genus.

The specific epithet *arida*, meaning *becoming dry*, is in reference to the semi-succulent karoo vegetation

NEW REHABILITATION
18804FIG. 3.—*Rhynchosia arida*. Acocks 15125, holotype in K.

in which the species grows. As far as I know, *R. arida* is the only *Rhynchosia* which is restricted to this habitat.

5. PSORALEA L.

Eriosema capitatum E. Mey., Comm. 130 (1836), was treated by Harv., Fl. Cap. 2: 262 (1862), as a species unknown. A close study of the protologue shows that *E. capitatum* cannot be an *Eriosema*.

'Caule erecto antrorsum appresso pubescentes canescentes, foliolis lanceolato-oblongo utrinque acutiusculis subtus incano-sericeis, capitulis subglobosis involucrentibus longe pedunculatis (italics mine)'.

There is no species of *Eriosema* in South Africa which has an involucrent subglobose flower-head. Furthermore, the type locality Ruigtervalli falls outside the distribution range of *Eriosema*. The protologue does, however, indicate features that might suggest *Psoralea* L.

A study of the literature indicates that *E. capitatum* should be placed in synonymy under *Psoralea tomentosa* Thunb., a distinctive Cape species. A problem arises, however, in that *P. tomentosa* Thunb., Prodr. 2: 135 (1800), is a later homonym of *P. tomentosa* Cav., Icon. 3: 21, t. 240 (1795), a validly described species from Mexico, now accepted as *Dalea tomentosa* (Cav.) Willd. The earliest available name for *P. tomentosa* Thunb. is *P. sericea* Poir.

Psoralea sericea Poir., Dict. 5: 687 (1804); in DC., Prodr. 2: 218 (1825); Meisn., in J. Bot., Lond. 2: 81 (1843); Drège, in Linnaea 19: 645 (1846); Presl, Bot. Bemerk. 60 (1844).

Rhynchosia sericeum Presl, Bot. Bemerk. 60 (1844).

Psoralea tomentosa Thunb., Prodr. 2: 135 (1800) non Cav. (1795); in DC., Prodr. 2: 218 (1825); Harv., Fl. Cap. 2: 156 (1862).

P. pedunculata Ker-Gawl. in Bot. Register t. 223 (1817) non Poir. (1816) nec Vail. (1891); Meisn., l.c. 2: 81 (1843).

Eriosema capitatum E. Mey., Comm. 130 (1836) syn. nov.; Meisn., l.c. (1843); Presl, Bot. Bemerk. 60 (1844); Harv., l.c. 2: 262 (1862).

Rhynchosia cephalotes Steud. Nom. 2, 2: 588 (1841), syn. nov.

6. ERIOSEMA G. Don

1. *Eriosema gunniae* C. H. Stirton, sp. nov., *E. cordato* E. Mey. affinis, a qua imprimis ramulis floriferis erectis brevioribus, floribus luteis et bracteis persistentibus aequantibus differt.

Herba perennis, 10–15 cm alta, verne florens. Rami erecti, pilis velutinis dense obtecti. Folia pro maxima parte 1-foliolata; 6–9 cm longa, 2,5–3,0 cm lata anguste elliptica vel anguste ovata usque lanceolata, apice acuta, cuneata, utrinque (sed praecipue in nervaturis) sericeo-pubescentia, glandulosa, margine aliquantum revoluta. Stipulae 15–20 mm longae, lanceolatae, coalitae, glandulosae et pilosae. Petioli 10–20 mm longi. Racemi axillares, 10–15-flori, foliis aequilongi; pedunculus 6–9 cm longus. Flores lutescentes, 8–10 mm longi; bractaeae ± 8 mm longae, persistentes. Calyx 5–7 mm longus, lobis aequalibus, pilis stramineis patentibus usque 2,5 mm longis dense obtectus, tubo 2 mm longo; lobi deltoidei, acuminati, lobus carinalis longior, laterales falcati, lobi cornuti non coaliti. Vexillum 9–10 mm longum, 4,5–5,5 mm latum, unguiculatum, reflexum, obovatum, extra glandulosum et pilosum, carina et alis longius; calli bene evoluti, conferruminati cucullati, ab auriculis prominentibus liberi. Alae 8,5–9,0 mm longae, 2,0–3,2 mm latae ad maximum, oblongae, auriculatae, carina longiores. Carina glandulosa et pilosa, laminis 6–7 mm longis, 3 mm latis ad maximum, marsupio evoluta. Vagina staminalis 5,5–6,0 mm longa, stamine discreto 5,4–6,0 mm longo, antheris uniformibus. Gynoecium 5 mm longum, ovarium 2,5 mm longum, cum gynophoro 0,5 mm longo, longe pubescens; curvatura 2,0 mm alta; stigma capitatum, ultra stamina exsertum. Nectarium evolutum, margine revoluta. Legumina et semina matura non visa.

TYPE.—Transvaal, 2530 (Lydenburg): Witklop Forest Research Station (–BD), Stirton 1482 (PRE, holo.).

Perennial herb, 10–15 cm tall, flowering in spring. Stems erect, densely covered with straw-coloured hairs. Leaves mostly 1-foliolate, 6–9 cm long, 2,5–3,0 cm wide, narrow-elliptic to narrow-ovate to lanceolate, apex acute, base cuneate, both sides sericeous especially along veins, glandular; margin somewhat revolute. Stipules 15–20 mm long, lanceolate, fused, glandular and hairy. Petioles 10–20 mm long. Racemes axillary, 10–15-flowered, equalling leaves, peduncle 6–9 cm long. Flowers yellow, 8–10 mm long. bracts ± 8 mm long persistent. Calyx 5–7 mm long, lobes equal, triangular, acuminate, keel lobe longest, laterals falcate, vexillar lobes free. Standard 9–10 mm long, 4,5–5,5 mm wide, clawed, reflexed, obovate, glandular and hairy, longer than keel and wings; appendages well developed, fused and hooded, free from prominent auricles. Wings 8,5–9,0 mm long, 2,0–3,2 mm wide at maximum, oblong, auriculate, longer than keel. Keel blades 6,0–7,0 mm long, 3 mm wide at maximum, glandular and hairy, pocket present. Staminal sheath 5,5–6,0 mm long, free stamen geniculate, 5,4–6,0



FIG. 4.—*Eriosema gunniae*. 1, habit; 2, stem with flowers, $\times 0.5$; 3, flower bract, $\times 7.5$; 4, flower, $\times 2.3$; 5, calyx opened out, $\times 5.3$; 6a, standard opened out, $\times 3.8$; 6b, standard closed, $\times 3.8$; 7, wings, $\times 3.8$; 8, keel, $\times 3.8$; 9, vexillar stamen, $\times 5.3$; 10, staminal sheath, $\times 5.3$; 11, staminal sheath closed with stigma and portion of style exerted, $\times 5.3$; 12, discoid floral nectary, $\times 15$; 13, gynoecium, $\times 5.3$; 14, stigma, $\times 33$.

mm long; anthers uniform. *Gynoecium* 5 mm long; ovary 2,5 mm long with 0,5 mm gynophore, densely covered with long hairs, curvature 2,0 mm high; stigma capitate, exerted beyond stamens. *Nectary* present; margin revolute. *Mature fruits* and seeds not seen. Fig. 4.

Restricted to the eastern Transvaal between Pilgrims Rest, Graskop, Witklip, Sudwala and Nels-hoogte (Fig. 2). This species is found on undisturbed grassy plateaux. It grows commonly in association with another rare legume, *Rhynchosia villosa* (Meisn.) Druce.

TRANSVAAL.—2430 (Pilgrims Rest): Pilgrims Rest (—DD), Rogers 14908; Graskop (—DD), Galpin 14580 Holland s.n. 2530 (Lydenburg); Witklip Forest Research Station (—BD), Stirton 1482; pass above Sudwala Caves (—DB), Grobbelaar 1439; Nels-hoogte (—DB), Muller 2157.

Eriosema gunniae was first collected near Pilgrims Rest in 1915. It has been commonly referred to *E. cordatum*, but can be distinguished by its stigma exerted from the staminal sheath and by its persistent flower bract that approximates the length of the flower. Four collections are included temporarily in *E. gunniae*: Young A72 from Middelburg, Young A214 from Susterstroom, Rudatis 2513 from Tautenberg and Grobbelaar 1675 from Steenkampbergen. This composite group occurs to the west of the range of *E. gunniae* sensu stricto. Further collections from the intervening areas may enable their correct status to be decided.

This distinctive *Eriosema* is named in honour of Miss Mary Gunn, who was a recipient of the 1976 Bolus Medal for outstanding achievement in the field of botany by an amateur botanist (see Veld & Flora 62: 30–31, 1976). Her knowledge of botanical literature and plant collectors has been of great importance to both South African plant taxonomy and taxonomists alike.

2. *Eriosema preptum* C. H. Stirton, sp. nov., affinitate incerta.

Herba perenna erecta 20–60 cm alta, flore vernalis. *Caules* 1–15, pilis albis brevibus trichomatibusque longioribus interspersis vestiti. Caudex stylopodio longo, gracilis moniliformis iuventute, aetate undulscens vel constringenscens sed dauciformescens. *Folia* trifoliolata raro infima unifoliolata (nunc vulgo obovata), 4,5–6,0 cm longa, 2,0–3,0 cm lata, lateralia minora asymmetrica, elliptica vel anguste obovata, apice subacuta, basin versus cuneata, sparse pubescentia, infra dense lanata, venibus prominentibus ob indumentum densum trichomatibus longioribus appressis, glandularia, marginibus revolutis. *Stipulae* 8–14 mm longae, libri. *Racemi* axillares, (8–) 25–35 florati ut pseudospicae congestae, folia subtendentia superantes. *Flores* 6–7 mm longi, ad 3 mm lati, aurantiaci venis rubribus vel croceaurantiaci, bractei 6 mm longi, cito caduci. *Lobi* calycis aequales, triangulares, tubam aequantes. *Vexillum* 6–7 mm longum, obovatum, appendix praesens connata, per summum unguem de auriculo in auriculum extensa; dorsum pubescens, glandulare. *Petala carinae* breviora quam alae. *Gynoecium* dense pubescens. *Fructi* 10–12 mm longi, 8 mm lati, molliter sericei. *Semini* grisei vel pallide brunnei, guttati vel maculati.

TYPE.—Natal, 2930 (Pietermaritzburg): Scottsville, Pietermaritzburg (—CB), Stirton 1242 (PRE, holo.; K, iso.).

Perennial herb, erect, 20–60 cm tall, spring flowering. *Stems* 1–15, clothed in short white hairs with

longer hairs interspersed. *Rootstock* with long stylopodium, thin and beaded when young but becoming wavy or constricted but carrot-like when mature. *Leaves* 3-foliolate, rarely the lowest leaves 1-foliolate (then mostly obovate), 4,5–6,0 cm long, 2,0–3,0 cm wide, laterals smaller and asymmetrical, elliptic to narrowly obovate, apex subacute, base cuneate, sparsely pubescent above, densely woolly below with veins prominent due to dense covering of longer appressed hairs, glandular, margins revolute. *Stipules* 8–14 mm long, free. *Racemes* axillary, (8–) 25–35 flowered in congested pseudo-spikes, overtopping the subtending leaves. *Flowers* 6–7 mm long, up to 3 mm wide, orange with red veins or yellow-orange; bracts 6 mm long, rapidly caducous. *Calyx* teeth equal, triangular, \pm equal to calyx tube. *Standard* 6–7 mm long, obovate, appendage present, fused, extending across top of the claw from auricle to auricle, back hairy and glandular. *Keel petals* shorter than wing petals. *Gynoecium* densely hairy. *Fruits* 10–12 mm long, 8 mm wide, softly sericeous. *Seeds* grey or light brown, with speckles or blotches. Fig. 5.

Eriosema preptum is endemic to Natal (Fig. 2) and extends some 100 km inland from the coastal belt. In the past it has been consistently called *E. squarrosun*, an unrelated Cape species. The nature of this confusion will be dealt with in detail in a subsequent paper on the *Eriosema squarrosun* complex. This species favours sandy sites along roadsides and ditches but is also commonly found in grassland.

NATAL.—2831 (Nkandla): Nkwaleni River Valley (—CB), Codd 1839; 18 km from Eshowe to Ginginghlovu (—DC), Stirton 1297. 2832 (Mtubatuba): Hluhluwe Game Reserve (—AA), Scott-Smith 10. 2930 (Pietermaritzburg): Pietermaritzburg (—CB), Stirton 368, 1139, 1242, 1410; 5 km from Table Mountain to Pietermaritzburg (—DA), Stirton 1032; near mid-Illovo (—DC), Stirton 1114. 2931 (Stanger): 43 km from Stanger to Mtunzini (—AB), Stirton 407, 1001, 1002; near Compensation (—BA), Stirton 1160. 3030 (Port Shepstone): 8 km from Eston to Winkelspruit (—BB), Stirton 1122.

3. *Eriosema transvaalense* C. H. Stirton, sp. nov., *E. cordato* E. Mey. affinis, sed floribus minoribus, pubescentia, florum colore seminibus differt.

Herba perenna ad 15 cm alta, flore vernalis. *Caules* multi, implexi, prostrati vel decumbentes, basi ramificantes, subtiliter pubescentes pilis flavescenscibus reflexis. *Folia* trifoliolata, infima semper unifoliolata, 3,5–6,5 cm longa, 2,5–3,5 cm lata rotundata vel ovata, ellipticescencia, ambo superficies virides, subtiliter pubescentes; ima venatione prominente elevata. *Stipulae* semiconnatae. *Rhachis* 3–4 mm longa. *Racemi* 6–8 florati, foliolos superantes. *Flori* laeti rosei flavique, 9–10 mm longi, 3 mm lati, bracteo ad 5 mm longo. *Calyx* 6 mm longa, lobi tubam subaequant. *Vexillum* 9 mm longum, 6 mm latum, obovatum, subcucullatum; dorsum tomentosum glandulare; appendices praesentes, supra unguem, connatae et ad auriculos leniter evolutos extensae. *Petala carinae* dense glandulares. *Gynoecium* 6 mm longum, ovarium dense pubescens. *Fructus* 15–16 mm longus, 10 mm latus, oblique oblongus rostro 2 mm longo, molliter flavo-pubescent, glandularis. *Semen* 5–6 mm longum, 3 mm latum, castaneum purpureomaculatum.

TYPE.—Transvaal, 2329 (Pietersburg): near Ebenezer Dam (—DD), Stirton 1438 (PRE, holo.; K, iso.).

Perennial herb, up to 15 cm tall, spring flowering. *Stems* many, matted, prostrate or decumbent, branching at the base, finely pubescent with reflexed yellowish hairs. *Leaves* 3-foliolate, with lower leaves

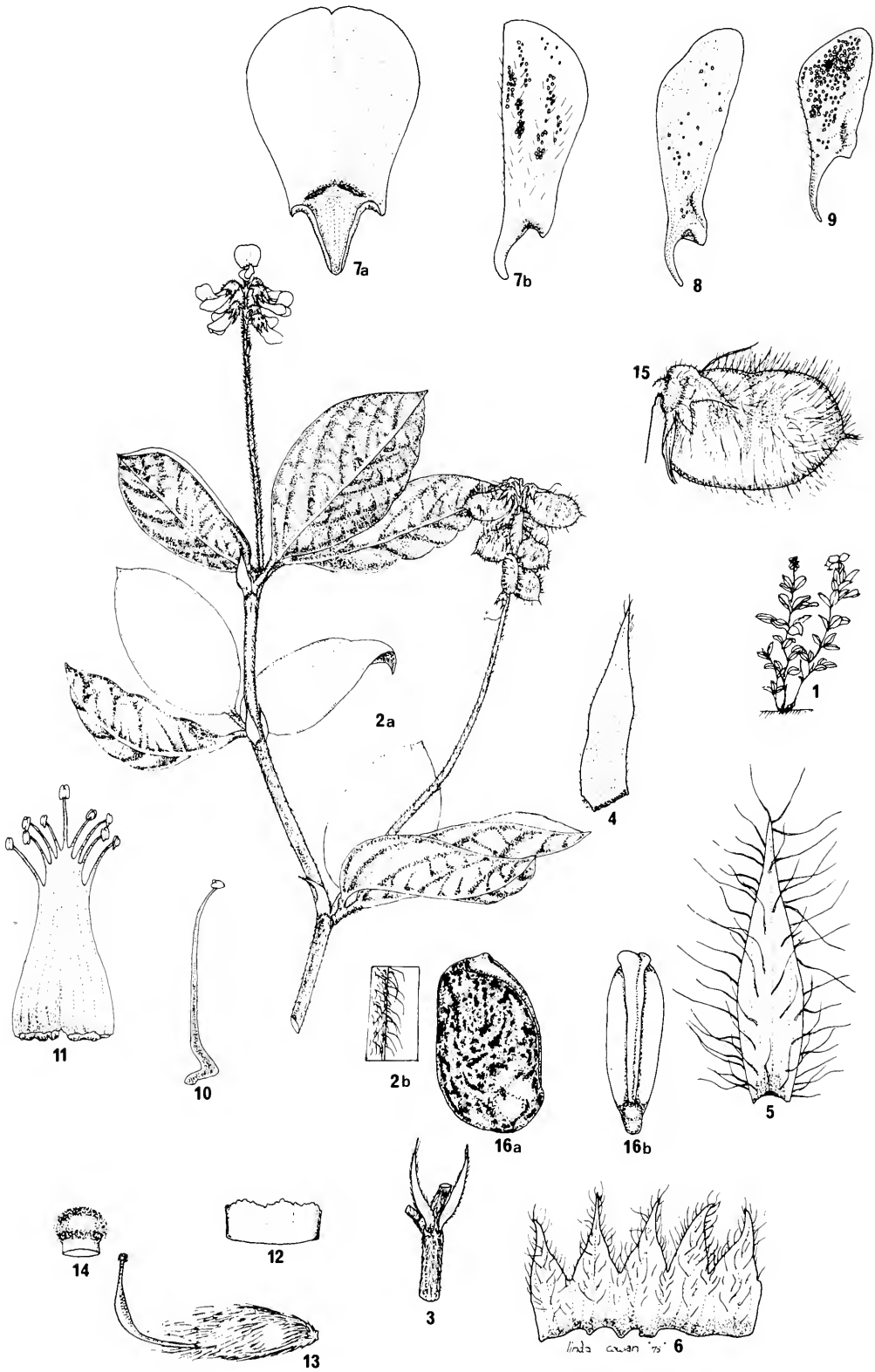


FIG. 5.—*Eriosema preptum*. 1, habit; 2, stem with fruits and flowers, $\times 0.5$; 2b, stem vesture, $\times 4$; 3, node showing free stipules, $\times 3.3$; 4, stipule, $\times 2.3$; 5, flower bract, $\times 7.5$; 6, calyx opened out, $\times 5.3$; 7a, standard opened out, $\times 3.3$; 7b, standard closed, $\times 3.3$; 8, wing, $\times 3.3$; 9, keel, $\times 3.3$; 10, vexillar stamen, $\times 5.3$; 11, staminal sheath, $\times 5.3$; 12, discoid floral nectary, $\times 15$; 13, gynoeceum, $\times 5.3$; 14, stigma, $\times 33$; 15, fruit, $\times 2$; 16a, seed with strophiole, face view, $\times 5.3$; 16b, seed with strophiole, marginal view showing hilum, $\times 5.3$.

always 1-foliolate, 3.5–6.5 cm long, 2.5–3.5 cm wide, rounded to ovate, becoming elliptic, both surfaces green, finely pubescent above and below, lower surface with prominent raised venation. *Stipules* semi-connate. *Rhachis* 3–4 mm long. *Racemes* 6–8 flowered, overtopping leaflets. *Flowers* pale pink and yellow, 9–10 mm long, 3 mm wide, bract up to 5 mm long. *Calyx* 6 mm long, teeth \pm equal to tube. *Standard* 9 mm long, 6 mm wide, obovate, somewhat hooded, back tomentose, glandular; appendages present, above the claw, fused and extending to weakly developed auricles. *Wing petals* 9 mm long, longer than keel, prominent peg present which fits tightly into the pocketed keel, sparsely glandular and hairy. *Keel petals* densely glandular. *Gynoecium* 6 mm long; ovary densely pubescent. *Fruit* 15–16 mm long, 10 mm wide, obliquely oblong with 2 mm long beak, softly yellow pubescent, glandular. *Seed* 5–6 mm long, 3 mm wide, chestnut brown with purple flecks. Fig. 6.

This species was collected for the first time as recently as five years ago and is endemic to isolated populations in the Magoebaskloof-Haenertsberg region (Fig. 2). *E. transvaalense* hybridizes with *E. angustifolium* Schinz. It grows in open grassland and is particularly evident along firebreaks.

TRANSVAAL.—2329 (Pietersburg): near Ebenezer Dam (—DD), Stirton 1438. 2330 (Tzaneen): Magoebaskloof Hotel (—CB), Stirton 1445.



FIG. 6.—*Eriosema transvaalense*. Stirton 1438, holotype in PRE.

ACKNOWLEDGMENTS

I should like to express my thanks to the following people. Messrs H. K. Airy-Shaw and R. D. Meikle and Dr R. K. Brummitt, Royal Botanic Gardens, Kew, for their indispensable advice and assistance with nomenclatural problems and Dr. H. F. Glen for two of the Latin translations.

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UITTREKSEL

Ses Psoralea-spesies van Afrika word na Cullen Medik. oorgedra: *C. biflora* (Harv.) C. H. Stirton, *C. holubii* (Burt Davy) C. H. Stirton, *C. drupacea* (Bunge) C. H. Stirton, *C. jaubertiana* (Fenzl) C. H. Stirton, *C. obtusifolia* (D.C.) C. H. Stirton en *C. plicata* (Del.) C. H. Stirton. *Psoralea patersoniae* Schönl., gebaseer op 'n ingevoerde tuinplant, word as 'n sinoniem onder *Cullen corylifolia* (L.) Medik. geplaas. Die volgende nuwe name word gepubliseer: *Lebeckia waltersii* C. H. Stirton van die subgenus *Plecolobium* C. H. Stirton; *Bituminaria bituminosa* (L.) C. H. Stirton van die subgenus *Bituminaria* en *B. acaulis* (Stev.) C. H. Stirton van die subgenus *Christevenia* Barneby ex C. H. Stirton; *Rhynchosia arida* C. H. Stirton; *Eriosema gunnii* C. H. Stirton, *E. preptum* C. H. Stirton en *E. transvaalense* C. H. Stirton. *Eriosema capitatum* E. Mey. word as 'n sinoniem onder *Psoralea tomentosa* Thunb. geplaas, maar aangesien *P. tomentosa* Thunb. 'n latere homoniem van *P. tomentosa* Cav. is, moet dit na *P. sericea* Poir. verwys word.

REFERENCES

- DANDY, J. E., 1967. Index of generic names of vascular plants 1753–1774. *Regn. Veg.* 51: 1–130.
 FORBES, H. M. L., 1930. The genus *Psoralea* Linn. *Bothalia* 3: 116–136.
 HOLUB, J. 1970. *Lamiastrum* versus *Galeobdolon* and comments on problems of unitary designations in Fabricius's work 'Enumerati methodica plantarum horti medici helmstadiensis'. *Folia geobot. phytotax.* 5: 61–88.
 MEIKLE, R. D., 1977. *Flora of Cyprus*. Kew: Bentham-Moxon Trust.
 RAUSCHERT, S., 1968. Zur frage der Gattungsnamen bei Fabricius. *Taxon* 17: 153–156.
 STAFLEU, F. A. & COWAN, A. S., 1976. *Taxonomic Literature*. 1: A–G. Utrecht: Bohn, Scheltema & Holkema.
 STIRTON, C. H., 1980. *Psoraleaceae*. In R. Polhill & P. Raven, *Advances in legume systematics*. 329–336. Kew: Royal Botanic Gardens.

The genus *Dipogon* (Leguminosae—Papilionoideae)

C. H. STIRTON*

ABSTRACT

A taxonomic revision of the genus *Dipogon* Liebm. is presented. Only one variable species, *D. lignosus* (L.) Verdc., is recognized.

RÉSUMÉ

LE GENRE DIPOGON (LEGUMINOSAE—CAESALPINIOIDEAE)

Une révision taxonomique du genre *Dipogon* Liebm. est présentée. Seule, une espèce variable, *D. lignosus* (L.) Verdc., est reconnue.

DIPOGON

Dipogon Liebm. in Index Sem. Hort. Acad. Hauniensi: 27 (1854) and in Annls Sci. nat., sér. 4, 2: 374 (1854); Verdc. in Kew Bull. 24: 406–409 (1971); R. A. Dyer, Gen. 1: 275 (1975).

Dolichos L. sect. *Eudolichos* Taub. subsect. *Barbatae* Taub. in Pflanzenfam. 3: 383 (1894).

Dolichos L. sect. *Pogonodolichos* Harms subsect. *Gibbosi* Harms in Pflanzenw. Afr. 3, 1: 679 (1915).

Verdcourtia Wilczek in Bull. Jard. bot. État Brux. 36: 250 (1966).

Perennial twiner, becoming woody below, thinly pubescent, glabrescent. *Leaves* pinnately trifoliate, petiolate, stipulate; leaflets ovate-acuminate to oblong-lanceolate, up to 7 cm long. *Flowers* purple, in short dense racemes on peduncles longer than leaves. *Corolla* 1.0–1.5 cm long. *Style* channelled, bearded along its upper margin, strongly curved near base and apex in same direction, the middle part being gently curved in opposite direction. *Legume* straight to falcate, 3–5 cm long, 4–5-seeded, style persistent; seeds black.

A monotypic genus found in the Cape Province from the Cape Peninsula to Grahamstown.

Dipogon lignosus (L.) Verdc. in Taxon 17: 537 (1968); Verdc. in Kew Bull. 24: 406 (1971).

Dolichos lignosus L., Sp. Pl. 726 (1753); Hort. Cliff. 360, t. 20 (1737); Aiton, Hort. Kew 3: 33 (1789); Smith, Specieg. Bot. 19, t. 21 (1792); Curtis's bot. Mag. 11: t.380 (1797); G. Don, Gen. Syst. 2: 237 (1832); Freeman in Bot. Gaz. 66: 512, f.3, 5, 6 & 7 (1918); Burkardt in Rev. Fac. Agron. Vet. Buenos Aires 6: 306 (1929); Burkardt, Las Leguminosae Argentinas, ed. 2: 422, f.128, j-k (1952); Maréchal & Otolu in Bull. Jard. bot. État Brux. 35: 73, f.14, t. F-H, photo. 4 (1965); Verdc. in Regnum veg. 40: 26 Adnot. (1965); Bronkers & de Keyser in Bull. Jard. bot. État Brux. 36: 57 (1966); Maréchal & Otolu in Bull. Rich. Agron. Gembloux, nov. sér. 1: 63, 1/2A (1966), non sensu Roxb. nec Prain et al. *Verdcourtia lignosa* (L.) Wilczek in Bull. Jard. bot. État Brux. 36: 254, f. 5–6 (1966). Neotype: t. 21 in Smith, Spicileg. Bot. (1792). For photo. see Bot. Gaz. 66: 520 (1918).

Dolichos gibbosus Thunb., Prodr. Fl. Cap.: 130 (1800); Fl. Cap. 590 (1823); Harv. in Fl. Cap. 2: 244 (1862); Marloth, Fl. S. Afr. 2: t.26 (1925); Levyns, Guide Fl. Cape Penins.: 155 (1929); Phill. in Flower. Pl. Afr. 11: t.402 (1931); Anon., S. Afr. Gdng Country Life 22: 87 (1932); Kidd, Wild Flow. Cap. Penins. t.41, 4 (1950). Lectotype: Cape, 'in collibus montium urbi Cap. b. Spei', Thunberg s.n. (UPS-16755, microfiche!).

D. capensis sensu Thunb., Prodr. Fl. Cap.: 130 (1800), non L.,

D. benthamii Meisn. in Hook., J. Bot. 2: 95 (1843). Type: Cape, 'in planitie capensi' (III.E.b.), Krauss 861.

D. gibbosus Thunb. var. *uniflorus* Harv. in Fl. Cap. 2: 244 (1862). Type: Cape, 'in collibus montium urbi Cap. b. Spei', Thunberg s.n. (UPS-16747, microfiche!).

D. jacquinii sensu Piper in Bull. U.S.D.A. 318: 5 (1915), non DC.

The typification of *Dolichos lignosus* L. has caused considerable difficulty and despite attempts by a number of authors to typify it, it has always been left unresolved (Freeman, 1918; Verdcourt 1971; Hutchinson, unpublished note; Dandy, unpublished note). It seems appropriate now that the plant has become quite widely cultivated and has even begun to assume weedy habits in Australia, that its correct status be established. Freeman (1918) and Verdcourt (1971) have given exhaustive accounts of the origin, usage and misuse of this name. I will therefore not repeat their arguments here, but briefly outline why I have chosen t. 21 in Smith's Spicileg. Bot. as the neotype even though the key diagnostic character in Sp. Pl. 726 (1753) 'leguminibus strictis linearibus' is not depicted in t. 21.

The protologue in Sp. Pl. 726 (1753) is as follows:

'lignosus. 9. Dolichos caule perenni, pedunculis capitatis, leguminibus strictis linearibus. Dolichos caule perenni lignoso. Hort. cliff. 360 t. 20. Phaseolus indicus perennis, floribus purpurascens. Eichr. carol. 36. Habitat---- h'

The effective diagnostic part of Linnaeus's definition lies in the words 'pedunculis capitatis, leguminibus strictis linearibus' as the first phrase 'Dolichos caule perenni' is repeated for *D. polystachios* the following species. It is also clear that the effective diagnostic part is omitted from Hort. Cliff. 360. There is no specimen of *D. lignosus* in the Linnaean herbarium, so one is forced to look elsewhere for a type. The first possibility is the cited plate in the Hortus Cliffortianus. This cannot be regarded as a lectotype, however, because the figured plant lacks fruit and does not have capitate flowers. Linnaeus actually stated in the text that his specimen did not produce fruit ('Absoluta florescentia absque fructu periit'). There is, however, a specimen in the Hort. Cliff which one might consider as a lectotype, since it is quite sterile. But it shows no sign of having

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FIG. 1.—*Dipogon lignosus*. 1, habit; 2, flowering branch, $\times 1$; 3, flower bract; 4, flower; 5, calyx opened out; 6a, standard opened out; 6b, standard closed; 7, wing; 8, keel; 9, vexillar stamen; 10, staminal sheath; 11, discoid floral nectary; 12, gynoecium; 13, stigma; 14a, seed, side view; 14b, seed, marginal view showing hilum.

borne an inflorescence and consists mostly of newly flushed growth; neither does it match the figured plate accompanying the Hort. Cliff. description of *D. lignosus*. The Hort. Cliff. specimen could be a *Dipogon*, but it is very difficult to be sure. For these reasons it is an unsuitable choice for a lectotype. The remaining possibility is Linnaeus's reference to Eichrodt's *Hortus Carolinensis*. However, he does not mention the fruit and, as the phrase name is vague, it also does not satisfactorily resolve the problem.

There are two noticeable changes in Linnaeus's Sp. Pl. and Hort. Cliff. accounts. In Hort. Cliff. he states 'Crescit in America', whereas in the Sp. Pl. he omits the origin of the plant altogether. This may indicate that his view of the species had changed, as it certainly did in the second edition of the Sp. Pl., where he included in synonymy 'cacara. s. phaseolus perennis' (a form of *Lablab purpureus*) and stated for the species as a whole 'Habitat in India'. Verdcourt (1971) has described the subsequent confusion which thence accompanied the names *Dolichos lablab* and *D. lignosus*. The second difference in the Hort. Cliff. and Sp. Pl. accounts is the inclusion in the latter of a description of the fruits.

The whole problem of typification of this species hinges, I believe, on Linnaeus's uncertainty about the nature of fruits in *Phaseolus* and *Dolichos* (*Vigna* was not known at the time as such and was treated by him under *D. lablab* and *D. lignosus*; see note by Linnaeus on p. 1015, Sp. Pl. 2.). It began when Linnaeus's concept of his species *D. lignosus* changed between his Hort. Cliff. treatment and his 1st edition of the Sp. Pl. I am fairly certain that when he added 'leguminibus strictis linearibus' he must have seen a fruit of a *Vigna* and not one of *Dolichos lignosus*. It is not known whence Linnaeus obtained his information about the fruit, neither did it help matters when, in his second edition, he included in the synonymy of *D. gibbosus* the name 'cacara. s. phaseolus perennis' now known to be a variant of *Lablab purpureus* and yet again with a different fruit.

One can either select a neotype and preserve the name *Dolichos lignosus* or abandon it. An acceptance that Linnaeus erred in his addition of the fruit character to his original phrase name in the Hort. Cliff. would allow one to accept one of the two distinctive and unambiguous plates published by Smith (Spicileg. Bot. t. 21, 1792) and by Curtis (Curtis's bot. Mag. 11: t. 380, 1797) shortly thereafter. It was only much later that the identity of *Dolichos lignosus* really became confused. The most parsimonious solution is, therefore, I think, to select Smith's t. 21 as the neotype of *Dolichos lignosus*, the basionym of *Dipogon lignosus* (L.) Verdc.

Voluble perennial arising from underground, vertical, deeply lenticelled rootstock with dichotomously branching laterals. Shoots spirally twisted, up to 3 m long, weak, glabrescent. Leaves trifoliate; stipules up to 6 mm long, basifixed, oblong-lanceolate, persistent, clasping but patent when old; petioles up to 5 cm long; leaflets 2–7 cm long, 1–4.5 cm wide, laterals smaller, stipellate, eglandular, paler beneath, glabrescent; terminal leaflet ovate-acuminate, laterals gibbous on lower margin. Petiolules up to 3 mm long. Rhachis 1–2 cm long, puberulent, armed with two persistent acrorhachial stipels. Racemes 5–10 (–33)-flowered, axillary, up to 25 cm long, longer than leaves, shortly and densely racemose towards apex, sometimes twisted; pedicels 5–10 mm long,

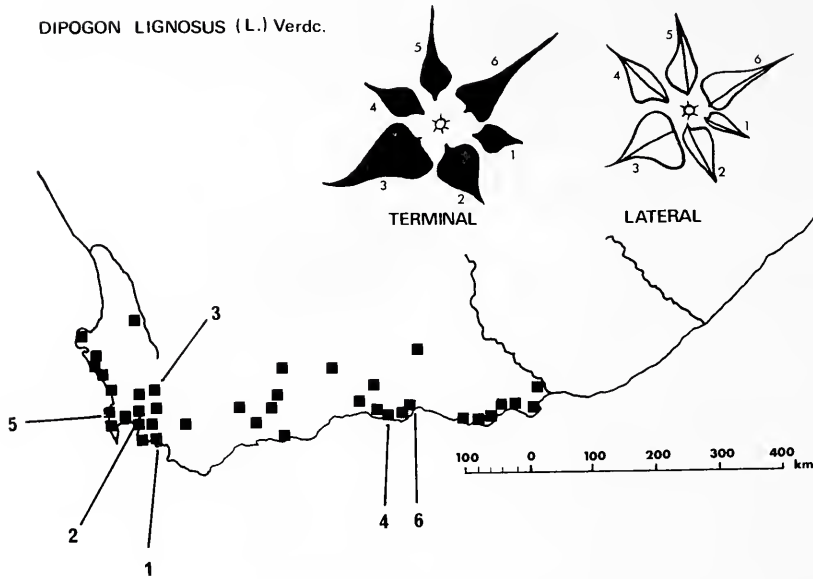
somewhat flattened, becoming purplish with age, armed with small caducous bracteoles near apex; bracts small, green, persistent until flower abscises. Flowers purple, turning pale mauve, 10–15 mm long, reflexed; bracts persistent; calyx campanulate, lobes 5, short and broad, tube twice longer than lobes, 2 horn (upper) lobes rounded, lateral and keel lobes triangular, ciliate. Standard 10–15 cm long and broad; apex emarginate, base auricled, with prominent appendages (callus lobes, callosities) situated low down extending from auricles to apex of claw, raised to form an entrance against which insects can thrust their thoracic region. Wings longer than keel blade, hanging slightly flared, with upper auricles inserted between appendages, pinkish. Keel blades rostrate, apex incurved, purple tipped. Stamens diadelphous, stamens held at two levels. Pistil sessile; ovary linear, with hairs along upper ridge; ovules 4–5; style channelled, bearded along upper inner margin, strongly curved near the base and apex in same direction, the middle part being gently curved in opposite direction; stigma capitate, fringed with hairs. Discoid floral nectary present. Legume 40–60 mm long, 8–10 mm wide, oblong, attenuate at base and apex, tipped with persistent style. Seeds 4–5, subglobose, 3.5–4.5 mm wide; hilum 2.5–3 mm long, black or speckled. Germination hypogeal, epicotyl absent; primordial leaves ovate, base cordate, opposite, petiole up to 1.8 mm long; stipules 2, undivided, oblong-lanceolate, persistent; acrorhachial stipels present. Chromosome number $2n = 22$. Fig. 1.

D. lignosus is endemic to the Cape Province and extends from the Cape Peninsula as far east as Grahamstown (Fig. 2). Its overall distribution falls within the fynbos. Flowering begins in July, reaches a peak in October then declines rapidly after December. This species grows commonly in scrub forests, along the perimeter of high forests (Galpin 1988 reports one plant overtopping a 6 m tree), and more recently it has been reported from waste places and gardens.

Despite a number of recent investigations into generic affinities in the Phaseoleae, there is still no agreement about the affinity of *Dipogon* to other genera. Lackey (1977a) placed *Dipogon* in the subtribe Phaseolinae Benth. between *Alistilus* N. E. Br. and *Dolichos* L., having suggested earlier (1977b) that *Dipogon* was closely related to *Lablab* Adans. and *Alistilus* and should perhaps be united with them. Baudet (1978), in contrast, placed *Dipogon* in the subtribe Phaseolinae, section Phaseolastrae, but *Alistilus* and *Dolichos* in section Dolichastrae. Maréchal, Mascherpa & Stainier (1978) suggested links with *Lablab*. They included both *Dipogon* and *Lablab* in their numerical analysis of the *Phaseolus* – *Vigna* complex. The peripheral affinity of *Dipogon* and *Lablab* to *Phaseolus* and *Vigna* (Maréchal *et al.*, 1978) would rather suggest, as already alluded to by Lackey (1977a) and Verdcourt (1970), that *Dipogon*, *Alistilus* and *Lablab* may be better considered allies of *Dolichos*. However, until the African representative of *Dolichos* are better known, this problem will have to be deferred.

The following herbarium material is recognized as *D. lignosus*:

SOUTH AFRICA.—Alexander s.n. (2 sheets), 46 (K); Archibald 4836 (PRE); Atherstone s.n. (GRA); Barker 1673 (GRA, PRE); Bayliss 108 (K, PRE), 2963 (PRE); Boucher 821, 1652 (PRE); Britten 78 (GRA), s.n. (Oct. 1946, 2 sheets, (GRA); Burchell 437, 6024, 7012 (K); Cummings 67 (RUH); Dahlstrand 837 (GRA, STE); Drège 278 (GRA), s.n. (K); Dyer 444 (GRA, PRE); Ecklon 1683 (K); Esterhuysen 709 (PRE), 23245 (K); Forest Department

DIPOGON LIGNOSUS (L.) Verdc.FIG. 2.—Known distribution of *Dipogon lignosus* in southern Africa.

Port Elizabeth 72 (GRA); Fourcade 1630 (GRA), 5739 (STE); Fries, Norlindh & Weimarck 567 (K); Gamble 22052 (K); Galpin s.n. (22.9.1897, PRE), 3988 (GRA); Garside 62 (K); Gerber s.n. (RUH); Gillett 103 (STE), 3376 (PRE, STE); Godfrey s.n. (11.12.1952, PRE); Grobbelaar 333 (PRE); Hafström & Acocks 2306 (PRE); Heeg 92 (RUH); Henry 16 (PRE); Herbarium Harvey 772 (BM, K); Hilner 86 (GRA); Hops 199 (GRA); Hooker 533 (K); Hutchinson 645 (BM, K), 1164 (K, PRE); Jordaan 3910 (STE), s.n. (STE 18592); Joubert 487 (STE); Keet 410 (GRA, STE), s.n. (STE 13499); Kerfoot K5508 (STE); Kies s.n. (5.9.1940, PRE); Kruger 343 (STE); Levyns 40 (BM); Lynes s.n. (BM); MacGillivray 504 (K); Marloth 13047, 13448 (PRE); Marsh 611 (PRE, STE); Miles s.n. (RUH); Morgan 12 (RUH); Muir 91A (PRE), s.n. (STE 10554); Nature Conservation Cape 208 (PRE); Nelson s.n. (BM); Noel 153 (RUH); Oliver 3627 (PRE); Pappe s.n. (K, 3 sheets); Patterson 361 (GRA); Phillips 357 (K); Pienaar K58 (STE); Pillans 3054 (PRE); Rodin 1030 (K, PRE); Rogers 1060, 2052 (BM), 4523 (GRA), s.n. (K), 26436 (PRE); Salisbury 206 (PRE); Salter 2058, 9313 (BM); Scharf 1401 (PRE); Schelpe 4166 (BM); Schlechter 2659 (GRA), 4704 (K), 9321 (BM, GRA, K); Schlieben & Ellis 12399 (K, PRE, STE); Schonland 533 (GRA); Shaw 43 (RUH); Smith 4832, 4930 (K); Story 317, 2593 (PRE); Stirton 6330 (PRE); Strey 797 (PRE); Taylor 4370 (STE); Theron 640 (PRE); Thode A917 (K, PRE), 8358 (STE); Thompson J. B. 56 (PRE); Thompson, M. 854 (K, PRE); Tyson s.n. (9.1916, PRE); Van Breda 17, 351 (PRE), 589 (K); Van Dam s.n. (12.1918, PRE); Van Rensburg 487 (PRE); Wallich s.n. (BM); White 5162 (PRE); Worsdel s.n. (K); Wolley-Dod 12 (BM, K); Zeyher 2413 (GRA, PRE), s.n. (GRA).

Verdcourt (1971) has already listed the cultivated material of *D. lignosus* housed in K. To this can be added Thomson s.n. (K) from Ceylon; Gamble 16999 (K) from India; Symon 9541 (ADW; K), Rodd 1493 (K; NSW) and Constable 7148 (K; NSW) from Australia; and Bangerter 5189 (AK; K) from New Zealand. *D. lignosus* has become naturalized in Australia and seems to be increasing its range there.

ACKNOWLEDGEMENTS

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UITTREKSEL

'n Taksonomiese hersiening van die geslag *Dipogon* Liebm. is onderneem. Net een veranderlike spesie *D. lignosus* (L.) Verdc., word erken.

REFERENCES

- BAUDET, J. C., 1973. Intérêt taxonomique des caractères épidermiques dans le complexe *Phaseolus* — *Vigna*. *Bull. Soc. bot. Belg.* 106: 53–59.
 FREEMAN, G. F., 1918. The purple hyacinth bean. *Bot. Gaz.* 66: 512–523.
 LACKEY, J., 1977a. A revised classification of the tribe Phaseoleae (Leguminosae: Papilionoideae), and its relation to canavanine distribution. *Bot. J. Linn. Soc.* 74: 163–178.
 LACKEY, J., 1977b. A synopsis of Phaseoleae (Leguminosae, Papilionoideae). Ph. D. thesis, Iowa State University, Ames.
 MARÉCHAL, R., MASCHERPA, J., & STAINIER, F., 1978. Etude taxonomique d'un groupe complexe d'espèces des genres *Phaseolus* et *Vigna* (Papilionaceae) sur la base de données morphologiques et polliniques, traitées par l'analyse informatique. *Boissiera* 28: 1–273.
 VERDCOURT, B., 1970. Notes on *Dipogon* and *Psophocarpus* (Leguminosae). *Kew Bull.* 17: 537–538.
 VERDCOURT, B., 1971. Studies in the Leguminosae — Papilionoideae. 3. *Kew Bull.* 24: 406–409.

Notes on the taxonomy of *Rubus* in southern Africa

C. H. STIRTON*

ABSTRACT

The taxonomy of *Rubus* in South Africa is beset with problems. These include the introduction of extra-African species as ornamentals and crops, the apparent segregation of new forms and finally hybridization with indigenous species. These problems are compounded by poor and incomplete collecting of *Rubus* in South Africa, and by the difficulty of relating introduced taxa to the many and varied species, varieties and ecotypes occurring in other countries.

RÉSUMÉ

NOTES SUR LA TAXONOMIE DU RUBUS EN AFRIQUE AUSTRALE

La taxonomie du *Rubus* en Afrique du Sud est assaillie de problèmes. Ceux-ci incluent l'introduction d'espèces extra africaines comme plantes ornementales et de cultures, l'apparente ségrégation de nouvelles formes et finalement l'hybridation avec des espèces indigènes. Ces problèmes se compliquent par des collections incomplètes et pauvres de *Rubus* en Afrique du Sud et par la difficulté d'apparenter les taxa introduits aux espèces nombreuses et variées, aux variétés et aux écotypes des autres pays.

Prior to the cytogenetic studies of Gustafsson (1942, 1943) there had been only a few studies such as those of Sudre (1908–1913), Focke (1911–1914) and Bailey (1941), that had attempted to produce an overall taxonomy of *Rubus*. By 1913 there were already some 3 350 Latin names in existence, many of which were applied to primary hybrids or very localized varieties (Gustafsson, 1943). As Newton (1975) has suggested, this may have been due to the vague species concepts prevailing at that time or it may have resulted from parochial attitudes adopted towards plants of widespread distribution. Nevertheless, from the work done by Gustafsson and other geneticists, we now know that much of the morphological diversity was a result of natural hybridization, polyploidy and apomixis.

Pseudogamy, a process whereby heterozygous segregates and hybrid derivatives can be maintained in nature, has played a particularly important role in the development of many agamic complexes in *Rubus* (Grant, 1971). A batologist not only has to contend with these basic genetic difficulties, but also has to deal with considerable phenotypic plasticity (Beijerinck, 1953; Heslop-Harrison, 1963). It is little wonder then that this remarkable genus had defied taxonomists for over three centuries and that there is still no consensus on supraspecific categories.

The problems of *Rubus* taxonomy in South Africa are aggravated by the introduction and naturalization of exotic species, the apparent segregation of new forms in areas surrounding cultivated blackberries, the role of hybridization among local, as well as between local and exotic species, and finally by inadequate herbarium material.

Harvey (1862) recognized five species of *Rubus* in South Africa: *Rubus fruticosus*, *R. ludwigii*, *R. pinnatus*, *R. rigidus* and *R. rosaefolius*. The last overall revision was by C. E. Gustafsson (1933) who added a further six species: *R. adolfi-friederici*, *R. chrysocarpus*, *R. ecklonii*, *R. immixtus*, *R. intercurrents* and *R. transvaalensis*. Also mentioned by Gustafsson were two species of introduced brambles: *R. affinis* and *R. argutus*, of which only the former was noted as a naturalized weed. Not included in any of these

studies are the now naturalized weeds *R. niveus* Thunb. (Java bramble), *R. cuneifolius* Pursh (American bramble) and *R. phoenicolasius* Maxim. (wine berry).

It is often difficult to decide whether certain species are indigenous or introduced. A case in point is *R. immixtus* C. E. Gust. The type locality of this species is Hogsback in the eastern Cape, an area which has an extremely variable *Rubus* flora and well noted for its large number of naturalized European plants such as gorse (*Ulex europaeus*), roses (*Rosa* spp.) and hawthorns (*Crataegus*). It seems quite probable, therefore, that *R. immixtus* may be either a European species or a hybrid with *R. rigidus* Sm. in its ancestry.

Gustafsson (1933) only catalogues one hybrid, *R. affinis* × *rigidus*, in his account Rubi Africani. If correct, this is a hybrid between an indigenous species and an introduced extra African species. What of the role of hybridization among indigenous species? Harvey (1862), under his doubtful species, recorded that an Ecklon and Zeyher specimen was 'almost intermediate between *R. pinnatus* and *R. rigidus*'. Adamson & Salter (1950) state that *R. pinnatus* hybridizes freely with *R. fruticosus* in the Cape Peninsula area. Focke (1911) reported two hybrids: *R. plicatus* × *pinnatus* and *R. pinnatus* × *rigidus*. The tremendous variability of *R. rigidus* and *R. pinnatus* in South Africa may well be explained by their apparent ability to hybridize with other species. It is interesting to note that Amor & Miles (1975) could find no trace of hybridization having occurred in Victoria, Australia, although they did not preclude this as a future possibility once the introduced species had increased their ranges.

These preliminary observations suggest that a taxonomic revision of *Rubus* in South Africa is highly desirable, but such a study would obviously be a long-term project. Although many modern revisions of *Rubus* are based largely on cytological investigations, it is nevertheless still necessary, in many parts of the world, to rely on herbarium material. If this material is inadequate or incomplete then the task becomes very difficult. The importance of complete herbarium collections has been stressed by a number of workers (Amor & Miles, 1974; Beijerinck, 1953; Edees, 1959; Watson, 1958). My impression, after having seen much of the available herbarium mate-

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rial in South Africa, is that few collectors have been aware of what would constitute adequate pressed material for the naming of a specimen of *Rubus*. For this reason, and because so little material is available for study and because some areas are undercollected, I have outlined the four components which make up a useful herbarium voucher (see also Amor & Miles, 1974; Beijerinck, 1953) — this in the hope that it will encourage collectors to collect more material.

It is important to collect:

1. One 10 cm section, with leaves, selected from the middle of a first-year cane of vegetative growth (primocane). *Rubus* usually, but not always, flowers in the second season. The first season or primocanes are easily recognized by their lush and robust growth.
2. One 10 cm section, with leaves, from the middle of a flowering cane (floricane). This is necessary as in most species of *Rubus* in South Africa the floricanes differ markedly in shape, size, leaf-shape and number, and presence or absence of a white bloom.
3. A complete inflorescence with flowers, and fruits if these are available.
4. A few petals dried separately. The petals of some species, if not collected separately, become lost during drying as they abscise rapidly after collection.

This dried material should be accompanied by full descriptive notes. Of great taxonomic value are the colours of petals, young and old fruits, primocanes and floricanes. The relative length and colour of stamens and styles, as well as the relative lengths of calyx lobes and petals which are often very diagnostic. It should also be noted whether canes are erect, arching or looping. Looping canes may tip-root during the Autumn equinox. Odd forms or unusual plants should also be collected with a note to that effect. It is important to accurately record the localities of oddities, particularly if they are collected near blackberry orchards or in areas known to be heavily treated with herbicides, as these chemicals are known to cause chimeras and unusual phenotypes.

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UITTREKSEL

Die taksonomie van Rubus in Suid Afrika is omring van probleme. Dit sluit in die invoer van spesies van buite Afrika as sierplante en gewasse, die oënskynlike segregasie van nuwe vorms en uiteindelijke verbastering met inheemse spesies. Hierdie probleme word vererger deur swak en onvolledige versameling van Rubus in Suid Afrika en omdat dit moeilik is om die verwantskap tussen ingevoerde taksons en die vele en uiteenlopende spesies, variëteite en ekotipes wat in ander lande voorkom, te toon.

REFERENCES

- ADAMSON, R. S. & SALTER, T. M., 1950. *Flora of the Cape Peninsula*. Cape Town: Juta.
- AMOR, R. L. & MILES, B. A., 1974. Taxonomy and distribution of *Rubus fruticosus* L. aggr. (Rosaceae) naturalized in Victoria. *Muelleria* 3, 1: 37–62.
- BAILEY, L. H., 1941. Species Batorum. *Gentes Herb.* 5, 1: 1–19.
- BEIJERINCK, W. 1953. On the habit, ecology and taxonomy of the brambles of the Netherlands. *Acta bot. neerl.* 1: 523–545.
- EDEES, E. S., 1959. The difficulties of a *Rubus* referee. *Proc. bot. soc. Br. Isl.* 3: 406–419.
- FOCKE, W. O., 1911–1914. *Species Ruborum*. Monographiae generis Rubi Prodrum 1–3. *Bibliotheca bot.* 17, 72: 1–223; 19, 83: 1–274.
- GRANT, V., 1971. *Plant speciation*. New York: Columbia University Press.
- GUSTAFSSON, A., 1942. The origin and properties of the European blackberry flora. *Hereditas* 28: 249–277.
- GUSTAFSSON, A., 1943. The genesis of the European blackberry flora. *Acta Univ. lund.* 39, 6: 1–200.
- GUSTAFSSON, C. E., 1933. Rubi africani. *Ark. Bot.* 26A, 7: 1–68.
- HARVEY, W. H., 1862. Rosaceae. In W. H. Harvey & O. Sonder (eds), *Flora Capensis* 2. Kent: Reeve.
- HESLOP-HARRISON, J., 1963. *New concepts in flowering plant taxonomy*. London: Heineman.
- NEWTON, A., 1975. *Rubus* L. In C. A. Stace (ed.), *Hybridization and the flora of the British Isles*. London: Academic Press.
- SUDRE, H., 1908–1913. *Rubi Europae*. Paris: Libraire des Sciences Naturelles.
- WATSON, W. C., 1958. *Handbook of the Rubi of Great Britain and Ireland*. Cambridge: University Press.

New records of naturalized *Rubus* in southern Africa

C. H. STIRTON*

ABSTRACT

Rubus niveus Thunb. and *R. phoenicolasius* Maxim. are recorded for the first time in southern Africa. Notes are given on their morphology, present distribution and weed status.

RÉSUMÉ

NOUVELLES ENRÉGISTRÉMENTS DU RUBUS NATURALISÉ EN AFRIQUE AUSTRALE

Rubus niveus Thunb. et *R. phoenicolasius* Maxim. sont enregistrés pour la première fois en Afrique australe. Des notes sur leur morphologie leur distribution actuelle et leur statut en tant que mauvaise herbe sont données.

INTRODUCTION

As pointed out in a previous paper (Stirton, 1981), the taxonomic problems of *Rubus* in southern Africa will only be solved after years of intensive field work and genetic and taxonomic evaluation. However, because an accurate taxonomy is economically important to silviculture and agriculture, results will be published as they become available. This paper records for the first time in southern Africa two introduced *Rubus* spp., which have become naturalized, namely *Rubus niveus*, the Java bramble and *R. phoenicolasius*, the wineberry.

TAXONOMY

1. *Rubus niveus* Thunb., Dissert. Rubi 9 (1813); Focke in Bibliotheca bot. 72: 182 (1911); Graham in Fl. Trop. E. Afr., Rosaceae 40 (1960); Hanizah, Toha & Van Steenis, Mountain Flora of Java, t. 45, 5 (1972). Type: *Thunberg* s.n. herb. no. 12275 (UPS, holo., photo.).

Primocanes up to 2 m, tip-rooting, bright green but covered with dense white bloom, eglandular, glabrous, round, prickles either patent or slightly deflexed (Fig. 3.1). Floricanes reddish, glabrous, mostly without bloom. Leaves 3–5-partite on floricanes, but mostly 7-partite on primocanes; upper surface of leaflets thinly hairy, sulcinate, dark yellow-green, lower surface white woolly with yellowish venation, occasionally armed with small recurved prickles; terminal leaflet broadly ovate or elliptic, apex acute to acuminate, base truncate to rounded, larger than laterals; petioles and petiolules tomentose, armed with falcate or deflexed prickles. Stipules free, ascending, becoming patent, winged at base (Fig. 3.2). Inflorescence broadly pyramidal or rounded, terminal, \pm 12-flowered on floricanes, 2 to 4-flowered on primocanes, mostly axillary, leafy, rhachis tomentose. Sepals up to 6 mm long, exceeding the petals, densely pilose, tips green and glabrous. Petals bright pink, shorter than calyx lobes, 5 mm long and wide, suborbicular with crinkled margins, apices incurved, touching. Anthers black, exceeding pink stigmas; filaments pink. Carpels densely tomentose (Fig. 4.1); fruits orange when young, turning red and finally greyish purple. Fig. 1.

Rubus niveus has a wide Asian distribution: Himalaya (Kashmir to Sikkim), S. India. Sri Lanka. Bur-

ma, Thailand, Laos, Vietnam, Malaysia, Java, Bali, Flores, Timor, Luzon and Celebes (Kalkman, 1976). In Africa it has been recorded from Kenya, Tanzania, Zimbabwe, South Africa and Swaziland (Fig. 2). Van Steenis (1976) considers the African plants to be conspecific with the Asian plants.

TRANSSVAAL.—2531 (Komatipoort): Ngomangoma Waterfall, 10 km south of Barberton (–CC), *Stirton* 1766; 12 km from Barberton on road to Havelock (–CC), *Stirton* 6857.

SWAZILAND.—2531 (Komatipoort): near Havelock Mine (–CC), *Codd* 7831. 2631 (Mbabane): Mbabane (–AC), *Miller* 5/200; The Taven (–AC), *Pritchard* s.n.; Usutu Forest (–CA), *Mott* 471; Ukutula (?), *Compton* 25060.

Java bramble has been found in grassland, along wooded stream-banks and among rocks in tall herb communities. It easily tolerates the semi-shaded conditions prevailing in *Eucalyptus* plantations, but tends to favour higher altitude areas between 1 000 and 1 600 metres. It flowers between January and April.

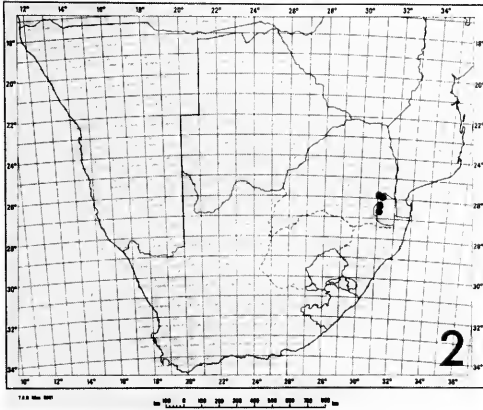
The origin of Java bramble in Africa is still speculative. Graham (1960) has suggested that this species may have been introduced into east Africa from India or Malaysia, but he cited no evidence. Is this species a recent introduction or has it occurred in Africa for a very long time? This question is difficult to answer and one can only surmise from what little indirect evidence there is. It is not known whether the species occurs in Malawi and its occurrence in Zimbabwe is difficult to explain. One of the Swaziland specimens (*Miller* 5/200) has a note that suggests *R. niveus* was introduced into Swaziland from Kenya. As regards South Africa, there seems little doubt that Java bramble is a recent arrival in the south-eastern Transvaal. Firstly, it is unlikely that early collectors such as Galpin and Thorncroft would have missed collecting such a distinctive species and secondly, my own observations are that Java bramble has rapidly expanded its range over the last five years. This extension has been particularly noticeable from Havelock in Swaziland into the Transvaal towards Barberton. Compton remarks in a note on his collection 25060 that the plant is a weed in the Ukutula area. During an excursion in 1977 to the Barberton-Havelock area, I gained the impression that if not checked Java bramble could become a menace in forests of the eastern Transvaal. Its eradication should begin now, while infestations are still small and economically controllable.

Previously in South Africa *R. niveus* was referred to either *R. intercurrents* C. E. Gust. or *R. immixtus*

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FIG. 1.—*Rubus niveus*. 1, mature second year plant with autumn primocanes; 2, 3-foliolate leaf from floricane; 4, 7-foliolate leaf from primocane; 5, autumn-induced morphological change in stem apices, showing stem tip rooting (Sturton 7146).



FIGS 2-5.—*Rubus niveus*. 2, Distribution in southern Africa. 3, part of primocane showing: 1, patent and slightly deflexed prickles; 2, ascending paired stipules. 4, tip of a 5-foliolate florican showing: 1, densely tomentose carpels; 2, glabrous, shiny sulcinate upper surface of leaflets; 3, recurved prickles. 5, under surface of a 7-foliolate primocane leaf showing strong nervation and under surface pubescence.

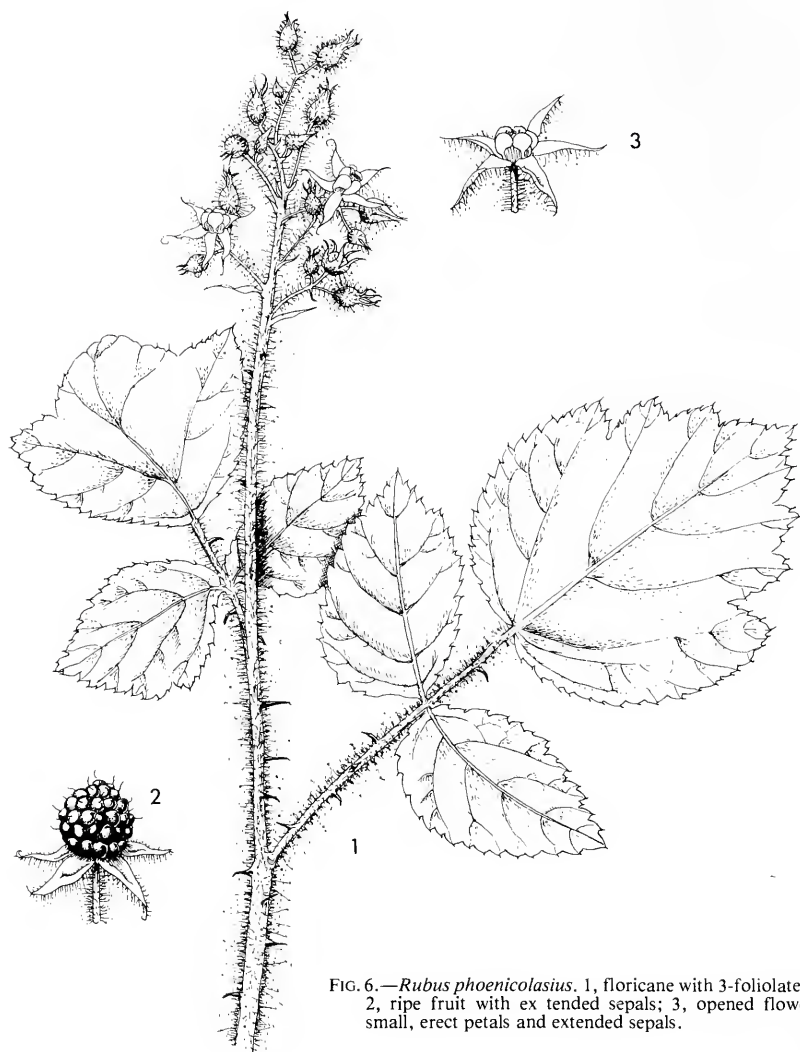


FIG. 6.—*Rubus phoenicolasius*. 1, floricane with 3-foliolate leaves; 2, ripe fruit with extended sepals; 3, opened flower with small, erect petals and extended sepals.

C. E. Gust. There is, however, only a superficial resemblance to these species. *R. niveus* is easily separated from these and most other *Rubus* spp. in South Africa by its distinctive concolorous leaves, almost paralleled secondary sulcate nervation (Fig. 5) together with its small pink flowers, tomentose fruits and white bloom on the primocanes. The nearest species which could be confused with it is *R. ludwigii* Eckl. & Zeyh., which also has similar flowers, hairy fruits, concolorous leaves and a white bloom. It differs from *R. niveus*, however, in its deeply incised leaflets and few secondary veins, regardless of the size of the leaflets.

R. niveus, like many European brambles of the subgenus *Eubatus* Focke, produces positively geotropic cane tips during the Autumn equinox when its fruits are ripening. By May the cane tips have entered the ground and have proliferated a mass of adventitious roots (Fig. 1.5).

2. ***Rubus phoenicolasius* Maxim.** in Izv. imp. Akad. Nauk. 17: 160 (1872); Hooker in Curtis's bot. Mag. t. 6479 (1880); Bailey in Gentes Herb. 5: 902 (1945).

Primocanes up to 2 m tall, robust, arching, tip-rooting, axis terete with scattered, straight or falcate prickles, densely covered by red acicles, stalked glands and a fine wispy white pubescence. Floricane axis similarly covered. Leaves 3-partite, or uppermost simple; petioles and petiolules with a thin wispy pubescence, short acicles and reddish glandular hairs, armed with falcate pricklets; upper surface of leaflets thinly-hairy, green or greyish green, lower surface densely white tomentose with straight pricklets scattered along the nerves; terminal leaflet broadly ovate, 7–10 cm long, 3–6 cm wide, cordate or subtruncate at base, apex abruptly short pointed, margins coarsely biserrate, apices of teeth apiculate; lateral leaflets smaller, oval, asymmetrical, 3–5 cm long. Stipules linear, persistent, adnate to base of petiole. Inflorescence a short 8 to 14-flowered terminal raceme. Sepals large, exceeding petals, glandular inside, glandular hairy outside, lanceolate, spreading in flower, closed during fruit maturation but open in ripe fruit. Petals white, shorter than sepals, erect, curved inwards, spatulate, apex crenate, outside ciliate. Stamens short. Carpels hairy; fruits ovoid, 1–2 cm long, composed of \pm red, ellipsoid glabrous drupes; seeds strongly reticulate. Fig. 6.

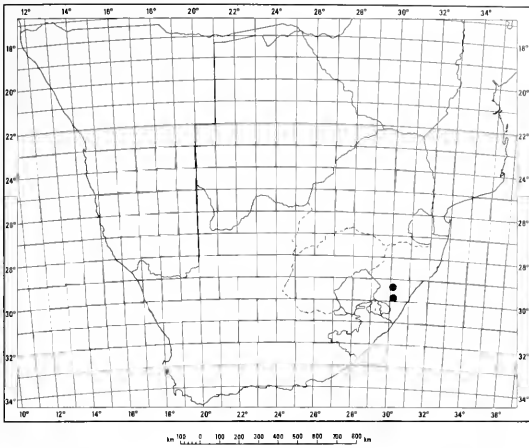


FIG. 7.—Distribution of *Rubus phoenicolasius* in southern Africa.

R. phoenicolasius is an introduced ornamental and berry plant that has escaped from gardens and is now locally naturalized in parts of the Natal Midlands (Fig. 7). It has been found in wasteland and in natural veld and is fairly rare. The earliest record of escape is 1950.

NATAL.—2930 (Pietermaritzburg): Balgowan (—AC), Marr & Scotney 8; Highlands, Richmond area (—CD), Beald 719.

Wineberry is native in Japan, North Korea, South Korea and northern China (Bailey, 1923). In Japan it occurs in plagiocseral grassland of the subarctic macroclimatic zones and is one of the principal species in the fourth (shrubby stage) of the six successional stages to climax (Numata, 1974). It was introduced from Japan into Europe by Maximovic in the 1870's (Hooker, 1880) and is today still cultivated for its ornamental value and its edible fruit (Heslop-Harrison, 1968). In 1890 it was introduced into the United States by John Childs from seeds obtained in Japan by G. Georgeson and sent to J. T. Lovett of New Jersey (Bailey, 1941). It has since escaped cultivation and is now established along roadsides, in thickets and in open woods in several parts of the north-eastern United States (Fernald, 1950). It is also naturalized in parts of Europe.

Wineberry undergoes normal meiosis, with $n = 7$ (Chomisbury, 1927) and $2n = 14$ (Darrow, 1937; Jinno, 1951; Britton & Hull, 1957). A number of attempts have been made to hybridize wineberry with commercial crops such as the European raspberry, *R. idaeus* L., especially to develop insect and disease-resistant strains. Wineberry is rather susceptible to raspberry mosaic virus (Zeffer, 1923; Giddings & Wood, 1925), α and β — leaf-curl viruses (Converse, 1962) and strawberry necrotic shock virus (Frazier, 1966). The raspberry mosaic virus is transmitted either by aphid vectors such as *Amphorophora rubi* or by grafting (Converse, 1962). The leaf-curl viruses are also transmitted by an aphid vector, *Aphis idaei*

(Stace-Smith, 1962). As this plant hosts a number of important raspberry diseases, it should be eradicated. Marr & Scotney 8 collected in Richmond was severely affected by a necrotic viral disease.

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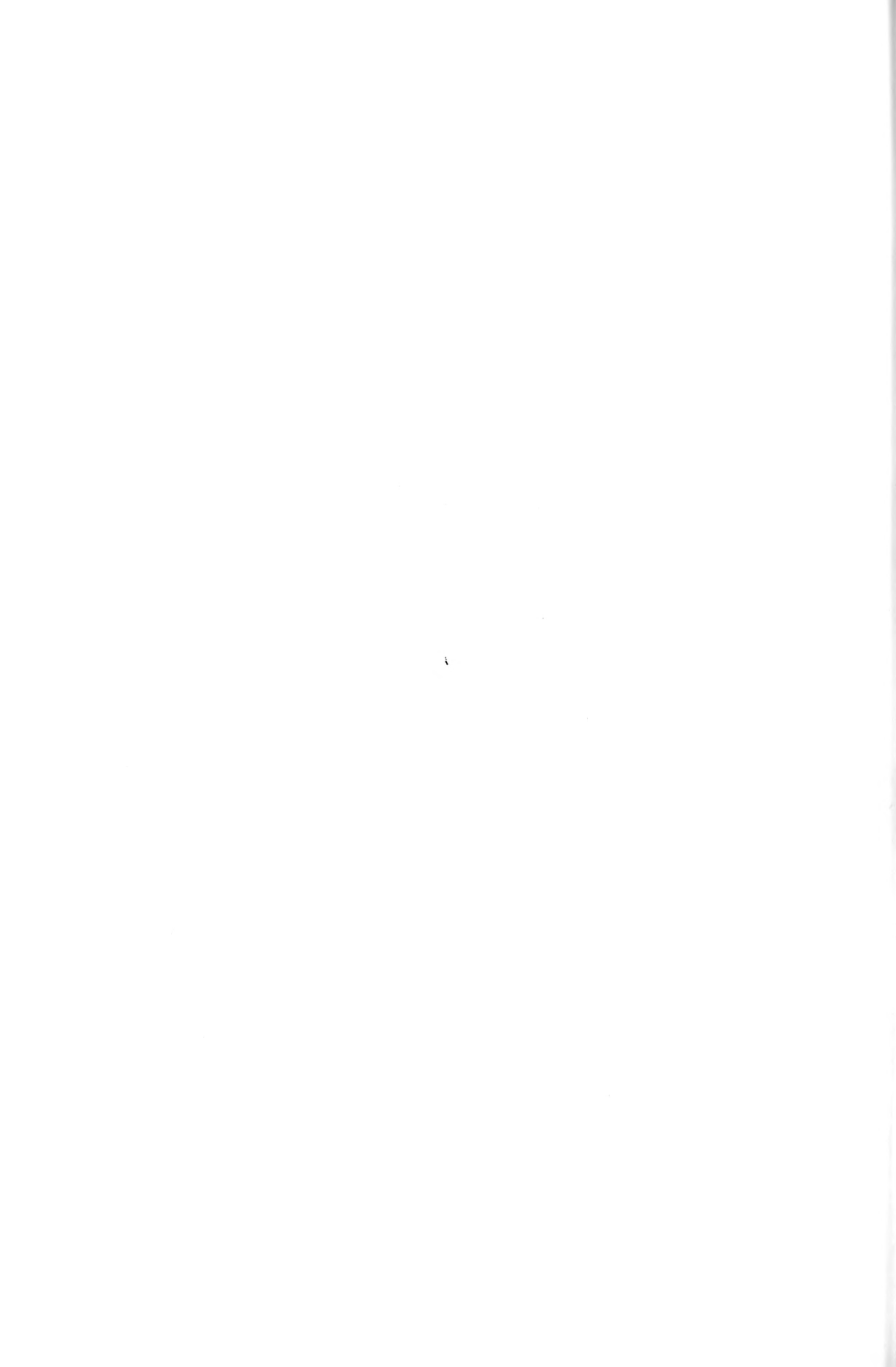
I am indebted to Professors C. Kalkman and C. J. van Steenis of Leiden for their useful comments; to Mr T. H. Arnold, at the time South African Liaison Officer in Kew and to Dr F. Kupicha for their careful investigation of the Kew material; to Mrs R. Weber for the artwork; to Mrs Romanowski for the photographs; to Dr L. E. Codd for his encouragement and critical interest; and finally to Prof. K. D. Gordon-Gray (University of Natal), Dr. R. L. Amor (Keith Turnbull Research Institute, Australia), Dr O. A. Leistner and Mr M. J. Wells for editorial comment.

UITTREKSEL

Rubus niveus Thunb. and *R. phoenicolasius* Maxim. word hier vir die eerste keer in Suid-Afrika erken. Die morfologie, verspreiding en onkruidstatus word bespreek.

REFERENCES

- BAILEY, L. H., 1923. Various cultivated Rubi aside from *Eubatus*. *Gent. Herb.* 1, 4: 147.
 BAILEY, L. H., 1941. Species Batorum. *Gent. Herb.* 5, 1: 1–19.
 BRITTON, D. M. & HULL, J. W., 1957. Chromosome numbers of *Rubus*. *Fruit var. hort. Dig.* 11: 58–60.
 CHOMISBURY, N., 1927. [The germinability and cytology of pollen of some varieties of *Prunus* and *Rubus*.] *Angew. Bot.* 9: 626–636. *Biol. Abstr.* 4: 1517.
 CONVERSE, R. H., 1962. Insect and graft transmission of alpha- and beta-curl viruses of raspberries. *Phytopathology* 52: 728. *Rev. appl. Mycol.* 42: 558.
 DARROW, G. M., 1937. Blackberry and raspberry improvement. *Yearbook USDA* 1937: 496–533.
 FERNALD, M. L., 1950. *Gray's manual of botany* 8th edn.
 FRAZIER, N. W., 1966. Natural and experimental infection of *Rubus* with strawberry necrotic shock virus. *Phytopathology* 56: 568–569.
 GIDDINGS, N. J., & WOOD, J. I., 1925. *Diseases of fruits and nut crops in the United States in 1924*. Pl. Dis. Repr. Suppl. 39. 105 pp.
 GRAHAM, R. A., 1960. *Rubus*. In *Fl. Trop. E. Afr., Rosaceae*, 21–40. London: Crown Agents for Overseas Governments and Administrations.
 HESLOP-HARRISON, Y., 1968. *Rubus* DC. In T. G. Tutin, V. H. Heywood, N. A. Burgers, D. M. Moore, D. H. Valentine, S. M. Walters, & D. A. Webb (eds), *Flora Europaea*. Cambridge: University Press.
 HOOKER, J. D., 1880. *Rubus phoenicolasius*. *Curtis's bot. Mag.* t. 6479.
 JINNO, T., 1951. [Chromosomes in *Rubus*. 2.]. *Jap. J. Genet.* 26: 133–135. *Pl. Breed. Abstr.* 29: 585.
 KALKMAN, C., 1976. Pers. Comm.
 NUMATA, M., 1974. Grassland Vegetation. In M. Numata (ed.), *The flora and vegetation of Japan*. Tokyo: Kodansha Scientific Books.
 STACE-SMITH, R., 1962. Studies on *Rubus* virus diseases in British Columbia. 8. Raspberry leaf-curl. *Can. J. Bot.* 40: 651–657.
 STIRTON, C. H., 1981. The taxonomy of *Rubus* in South Africa. *Bothalia* 13: 331–332.
 VAN STEENIS, C. J., 1976. Pers. Comm.
 ZELLER, S. M., 1923. *Mosaic and other systemic diseases of brambles in Oregon*. Circ. Oregon. agric. Exp. Stn 491, 15 pp.



Taxonomic studies in the Disinae. V. A revision of the genus *Monadenia*

H. P. LINDER*

ABSTRACT

The genus *Monadenia* (Disinae, Orchidaceae) is revised. Sixteen species arranged in four sections are recognized. The distribution of each species is plotted, and 12 species are illustrated. A hypothesis on the phylogenetic relationships of the species is presented.

RÉSUMÉ

ÉTUDES TAXONOMIQUES DES DISINAE. V. UNE RÉVISION DU GENRE MONADENIA

Le genre *Monadenia* (Disinae, Orchidaceae) est révisé. Seize espèces arrangées en quatre sections sont reconnues. La distribution de chaque espèce est située, et 12 espèces sont illustrées. Une hypothèse sur les relations phylogénétiques des espèces est présentée.

INTRODUCTION

Monadenia Lindl. is a small genus of 16 species, which is closely related to *Disa* Berg. (Orchidoideae, Orchidaceae). Fifteen of the 16 species are restricted to the Cape Flora Floral Region (Goldblatt, 1979), whereas the remaining species is rather widespread in the montane grasslands (White, 1978) of southern Africa (Fig. 1). The plants are generally less than 300 mm tall, and have rather inconspicuous green to brownish flowers.

The first species of *Monadenia* were described by Thunberg in 1794 as *Satyrrium*, and were transferred to *Disa* by Swartz (1800). The genus *Monadenia* was erected by Lindley in 1838. He included eight species in this genus, of which five were new species. However, he sowed the seeds for later nomenclatural confusion by misapplying *M. rufescens* (Thunb.) Lindl. to another taxon, later to be named *M. comosa* by Reichb. f. (1847). The true *M. rufescens* he named *M. macrocera*. He also gave the new names *M. micrantha* and *M. prasinata* to what should have been *M. bracteata* and *M. cernua*, respectively. Sonder (1847) and Reichenbach (1847) added four new names and one new species to the genus. Our knowledge of the genus was greatly extended by Harry Bolus and Rudolf Schlechter, who described four new and rather rare species in the genus. The last species was added to the genus in 1948 (Lewis, 1948).

To date there have been four taxonomic revisions of the group: Lindley (1838), Kraenzlin (1900), Schlechter (1901) and Rolfe (1913). Lindley only had material of half the presently known species before him. By 1900 the majority of species were known, or at least available in the European herbaria. However, Kraenzlin missed several species, and his work shows that he did not have access to sufficient material. Schlechter's and Rolfe's work differ in approach. Whereas Schlechter employed a broad species concept (combining *M. physodes* with *M. cernua* and *M. reticulata* with *M. macrostachya*), Rolfe raised almost every possible taxon to specific rank. Two species, *M. basutorum* (Schltr.) Rolfe and *M. leydenburgensis* Kraenzl., are here transferred to *Disa*, and have not been discussed above, and are excluded from Table 1.

The rank of the group has been controversial. Lindley (1838) recognized the group as a distinct genus, allied to *Disa*. This treatment was followed by Reichenbach (1847) and Sonder (1847), Bolus (1888, 1889, 1893, 1911, 1913) and Schlechter (1898, 1901) recognized *Monadenia* as a section of *Disa*. However, Rolfe (1913) maintained *Monadenia* as a distinct genus, as did Phillips (1926), Schelpe (1966) and Dyer (1976). The reasons for treating *Monadenia* as a distinct genus in this study will be dealt with in detail in another publication.

MORPHOLOGY

All the species in *Monadenia* may be shown to be rather minor variations on a simple pattern: erect herbs with linear to ovate cauline leaves, inflorescence a spike, dorsal sepal erect or curved forwards and shallowly galeate, oblong to obovate, spur straight, cylindrical, pendent from the base of the galea, lateral sepals somewhat smaller than the dorsal sepal, patent or reflexed, petals erect, obliquely ovate-oblong, retuse or truncate, lip linear to elliptic, pendent, lip and petals fleshy, rostellum simple with a deep central notch for the single large viscidium.

As in the rest of the subtribe Disinae, there are two

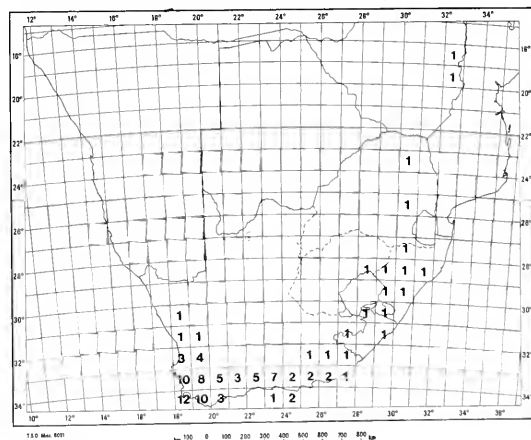


FIG. 1.—Distribution of the genus *Monadenia*. The number of species occurring in each grid square is indicated. The collection from Madagascar is not included.

*Bolus Herbarium, University of Cape Town, Rondebosch, 7700.

TABLE I.—Summary of the history of *Monadenia*

	Thunberg	Swartz	Ker	Lindley	Sonder	Reichb. f.	N.E.Br.	Bolus	Kraenzl.	Schltr.	Rolfe	Lewis
<i>M. ecalcarata</i>												x
<i>M. conferta</i>								x	x	x	x	
<i>M. pygmaea</i>								x	x	x	x	
<i>M. sabulosa</i>								x	x	x	x	
<i>M. bracteata</i>		x							x			
				micrantha					micrantha	micrantha	micrantha	
<i>M. densiflora</i>				x					x			
					multiflora				multiflora	multiflora	multiflora	
								auriculata	auriculata	auriculata	auriculata	
<i>M. macros-</i>												
<i>tachya</i>				x						x	x	
<i>M. reticulata</i>								x	x		x	
<i>M. comosa</i>				rufescens		x	affinis		x	x	x	
<i>M. bolusiana</i>										x	x	
<i>M. atro-</i>												
<i>rubens</i>										x	x	
<i>M. ophry-</i>												
<i>deae</i>				x					x	x	x	
<i>M. rufescens</i>	x	x		macrocera	lancifolia				x	x	macrocera	
<i>M. physodes</i>		x									x	
<i>M. cernua</i>	x	x	prasinata	prasinata	inflata				x	x	prasinata	
<i>M. brevis-</i>												
<i>cornis</i>				x					x	x	x	

Species excluded: *M. basutorum* (Schltr.) Rolfe = *Disa basutorum* Schltr.
M. leydenbergensis Kraenzl. = *Disa stachyoides* Reichb. f.

testicular tubers. There may be some variation in the tuber shape, but this variation is difficult to quantify due to lack of material.

The variation in leaf shape may be used to some extent to subdivide the genus: in sect. *Densiflora* the leaves tend to be linear-lanceolate, as compared to the more lanceolate leaves of the other sections. *M. comosa*, the only species that often occurs in half-shaded conditions, has rather distinctive spreading ovate leaves, sharply differentiated from the upper sheathing cauline leaves.

Inflorescence shape also more or less follows the sectional classification. The small-flowered sect. *Densiflora* has compact cylindrical spikes, the large-flowered sect. *Monadenia* semi-dense cylindrical spikes, and in sect. *Tenuicornes* the inflorescence tends to be lax. *M. sabulosa* and to a lesser extent *M. pygmaea* have an obovate inflorescence. This variation may also be expressed in the angle between the stem and the ovaries: in sect. *Densiflorae* the ovaries spread away from the axis, whereas they are almost erect and adpressed to the axis in sect. *Tenuicornes*. Only in sect. *Tenuicornes* do the floral bracts show any sharp discontinuities: in *M. rufescens* the bracts are almost of a leathery texture, partially obscuring the flowers and imbricate, whereas in *M. reticulata*, *M. comosa* and *M. bolusiana* they are of a more membranous texture, with the venation clearly visible on dried specimens, and the bracts not imbricate.

There is little variation in the shape of the dorsal sepal. In the majority of taxa the galea is best described as oblong. In some, i.e. *M. sabulosa*, the galea is obovate. There is some variation in the angle at which the galea is held: from vertical to falcately curved forwards, but this is difficult to quantify.

The lateral sepals are almost invariably oblong. In some taxa the sepals are reduced in size relative to the dorsal sepal. This is often associated with being reflexed (e.g. *M. sabulosa*). Generally, the apical parts of the sepals are recurved (e.g. *M. bracteata*). This is considered to be the primitive state. Presumably derived from this state are the sharply

reflexed sepals of *M. sabulosa* and *M. atrorubens* or the spreading sepals of *M. ophrydea*.

The petal structure is remarkably uniform throughout the group, and the variation is often rather subtle. This is shown rather clearly by *M. rufescens*, in which the petal shape differs marginally from *M. reticulata*, but the angle and the juxtaposition to the galea is somewhat changed, with a markedly different effect. *M. sabulosa* and *M. pygmaea* are somewhat distinct by virtue of the bifid petals.

Lip shape varies from linear to elliptic in the genus, and the shape is constant for each species. In sect. *Tenuicornes* it may be used as a good differentiating character for the different species.

Rostrum structure is dominated by the small anther, often partially pendent, and the single large viscidium. The rostrum is comparatively simple with a deep notch in which the viscidium is held. The rostrum is often flanked by two erect flanges of tissue, which may also flank the anterior part of the anther. The size of these flanges varies among the species. The origin of these flanges is not known. They may be derived from the staminodes.

The viscidium is generally an almost square structure. However, in *M. rufescens* it is elongated to the back, and has a deep dorsal groove. The two pollen-masses may be as long as or shorter than the caudicles.

The stigma is variable in shape. In general, the two lateral lobes are larger than the posterior lobe. In some cases the stigma is sessile at the base of the rostrum, in others it may be on a tall, often curved, stipe as in sect. *Tenuicornes*.

The spur length and shape provides a very valuable character and has been used as the diagnostic character for the sectional delimitation. In sect. *Tenuicornes* the spur is slender, acute and longer than the dorsal sepal. In sect. *Monadenia* it is much inflated, shorter or longer than the galea, obtuse, rounded or acute. In sect. *Densiflorae* the spur is as long as or shorter than the galea, slender or subclavate, acute to retuse, occasionally constricted at the base.

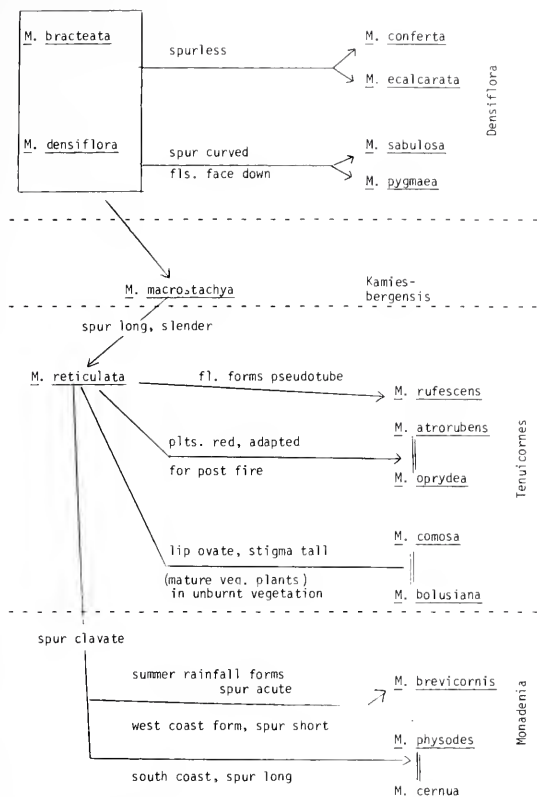


FIG. 2.—Postulated phylogenetic relationships among the species in *Monadenia*.

The morphological relationships in the genus are summarized in the cladogram in Fig. 2. The sectional classification is based on flower size, inflorescence shape and spur shape and length. The first two characters are related to each other, and also to overall plant size. Other characters that vary within the genus (sepal reflexion, stigma size, lip shape and leaf structure) have been found to vary between otherwise obviously closely related taxa (e.g. *M. atrorubens* and *M. ophrydea* for sepal reflexion, lip shape, stigma size, and *M. comosa* and *M. bolusiana* for leaf shape), and are therefore, unlikely to reflect evolutionary tendencies.

PHYLOGENY AND EVOLUTION

The postulated phylogeny of the genus is derived from the relationships among the taxa as indicated by the morphological data. However, to arrange the taxa into a sequence, ancestral and derived character states have to be suggested. The relative age of the extant taxa may be estimated from eco-geographical data.

Ancestral character states are probably those states found in other taxa in the *Disinae*, and also simpler states from which more complex states may be derived. In *Monadenia* the ancestral form was probably a slender herb with narrowly lanceolate, subimbricate cauline leaves, an inflorescence with numerous medium-sized flowers with the sepals about 6 mm long, spreading to slightly reflexed, subequal, the dorsal sepal shallowly galeate with a slender spur as

long as or slightly shorter than the sepal, subpendent, petals falcate, erect next to the rostellum, wider towards the base, lip lorate, obtuse, pendent, anther subpendent, rostellum low with a single viscidium, stigma sessile. Such a plant would be comparable to the suggested ancestral forms found in several sections of *Disa* (*Disa polygonoides* Lindl., *D. vaginata* Lindl. and *D. obtusa* Lindl.). In *Monadenia*, *M. bracteata* has the greatest similarity to this set of character states.

Relatively older species may be expected to be morphologically isolated, often with relic distributions in the form of widely scattered populations over large distribution areas, and possibly with wide ecological amplitudes. Morphologically isolated species are found in sect. *Densiflorae* (*M. sabulosa*, *M. pygmaea*, *M. ecalcarata* and *M. conferta*), whereas in the rest of the genus only *M. rufescens* is morphologically clearly isolated.

Several species in the genus show wide distribution ranges (*M. bracteata*, *M. densiflora*, *M. comosa* and *M. reticulata*), but only *M. densiflora* and *M. reticulata* have disjunct distributions. The majority of the species show a restricted distribution range, either on the west coast, or the south coast, or the area bounded by Caledon, Worcester and Cape Town. Two species are only known from very restricted localities: *M. ecalcarata* from a single specimen on the Cape Peninsula and *M. macrostachya* from a single locality in the Kamiesberg.

All the species in sect. *Densiflorae* have at least some morphologically or distributionally primitive features: *M. bracteata* and *M. densiflora* with widespread distributions and being morphologically ancestral, and the remainder of the species in the section being morphologically isolated.

The remaining species in the genus are grouped into interlinking species groups, in which the individual species are often difficult to separate rigorously. They present the aspect of a rapidly evolving group. Sect. *Tenuicornes* has diversified mainly in the mountains of the Cape, with one group adapted for the immediately post-fire temporal niche (*M. ophrydea* and *M. atrorubens*), with suitable cryptic coloration, and the other group adapted for unburnt vegetation, with one species found on rock ledges and the other at high altitudes in high-altitude low heathlands (Taylor, 1978) (*M. comosa* and *M. bolusiana*). One isolated species in the section appears to have become specialized for a particular pollination syndrome (*M. rufescens*). These five species therefore show a certain degree of specialization, and may all be derived from *M. reticulata*, the widespread and presumably simplest member of the section.

Sect. *Monadenia* has a rather specialized spur shape, and is a lowlands group, except in the summer rainfall area. The three species are geographically separated.

The single member of sect. *Kamiesbergenses* is best understood as the link between the older sect. *Densiflorae* and the derived remainder of the genus.

These postulated phylogenetic relationships are simplistically displayed in Fig. 2.

MONADENIA

Monadenia Lindl., Gen. Sp. Orch. 356 (1838); Benth. & Hook. f., Gen. Pl. 3: 630 (1883); Pfitzer in

Natürl. Pflfam. 2, 6: 98 (1889); Kraenzl., Orch. Gen. Sp. 1: 808 (1900); Rolfe in Fl. Cap. 5, 3: 186 (1913); Senghas in Schltr., Die Orchideen 1: 274 (1972); R. A. Dyer, Gen. 2: 995 (1976). Type species: *Monadenia brevicornis* Lindl., Gen. Sp. Orch. 357 (1838) (lectotype).

Disa Berg. sect. *Monadenia* (Lindl.) H. Bol. in Trans. S. Afr. phil. Soc. 5: 137 (1888); Schltr. in Bot. Jb. 31: 202 (1901).

Monadenia brevicornis is here selected as the lectotype, since it is the only correct name Lindley placed in the genus in 1838.

The generic name refers to the single viscidium and is derived from the greek 'monos' = one and 'adenos' = gland.

Leaves all cauline; dorsal sepal shallowly galeate, spur pendent from the base of the galea; petals obliquely ovate-oblong, subcarinate, partially exerted from the galea; lip linear to elliptic, subcarinate; anther usually semi-pendent, with a single large viscidium.

Plants terrestrial, herbaceous, usually erect, 40-600 mm tall; tubers 2, testicular or cylindrical; basal sheaths hyaline, obtuse; leaves all cauline, usually imbricate, the leaf bases sheathing, the blades elliptic to linear-lanceolate, usually erect, the lowermost the largest, the upper grading into the floral bracts; inflorescence cylindrical to secund, dense to lax; ovaries usually twisted, 5-25 mm long; bracts ovate to lanceolate, acute to acuminate, slightly shorter than the ovaries to longer than the flower. *Flowers*

resupinate (except *M. ecalcarata* Lewis), purplish, brown or green; dorsal sepal shallowly galeate, usually oblong, obtuse, 2.5-15 mm long; spur pendent from the base of the galea, slender or clavate, obsolete or longer than the galea; lateral sepals patent or reflexed, usually oblong, often shorter than the galea; petals generally obliquely narrowly ovate-oblong, acute to bifid, the broad base enclosing the anther and the apex erect in the galea, partially exerted from the galea; lip patent to pendent, linear to elliptic, subfleshy; anther horizontal to semipendent with a single large concrete viscidium and two cells; rostellum simple with a deep notch containing the viscidium and with two often well developed lateral flanges flanking the anterior part of the anther; stigma equally or unequally tripulvinate, shortly stipitate to as tall as the rostellum.

Sect. *Densiflora* Linder, sect. nov., calcar sepalis dorsalo plerumque brevior, sepalis 2.5-5 (-7) mm longis, inflorescentia densa dignoscenda.

Spur usually shorter than the dorsal sepal, rarely as long as the dorsal sepal; flowers small, sepal 2.5-5 (-7) mm long; inflorescence dense, cylindrical.

Type species: *Monadenia bracteata* (Swartz) Dur. & Schinz.

This section is linked to the rest of the genus by *M. densiflora*. In the *M. densiflora*/*M. bracteata* group the spur is straight or slightly curved, and about as long as the dorsal sepal. From this group two lines of development may be postulated: a line in which the spur is highly reduced, and flower size is decreased

KEY TO SPECIES

1a Spur as long as or shorter than the dorsal sepal:

2a Spur saccate or obsolete:

3a Inflorescence slender, 10 mm in diameter; lateral sepals 2.5 mm long 2. *M. conferta*

3b Inflorescence stout, 15 mm in diameter; lateral sepals 4 mm long 1. *M. ecalcarata*

2b Spur well developed, more than 1 mm long:

4a Spur clavate, rounded 14. *M. physodes*

4b Spur slender:

5a Spur about as long as the dorsal sepal:

6a Spur with a sharp bend; petals deeply bilobed 3. *M. sabulosa*

6b Spur straight or gently curved; petals rounded to obtuse:

7a Lateral sepals c. 7 mm long 7. *M. macrostachya*

7b Lateral sepals less than 4 mm long 5. *M. bracteata*

5b Spur about 1/2 as long as the dorsal sepal:

8a Spur constricted at the base and triangular in cross-section 6. *M. densiflora*

8b Spur cylindrical; not constricted at the base 4. *M. pygmaea*

1b Spur longer than the dorsal sepal:

9a Spur clavate:

10a Spur rounded 15. *M. cernua*

10b Spur acute 16. *M. brevicornis*

9b Spur slender:

11a Plants suffused beetroot-red when fresh, reddish brown when dry:

12a Lip 8-10 mm long, narrowly elliptic to lorate; lateral sepals spreading 12. *M. ophrydea*

12b Lip 5-7 (-8) mm long, oblong to narrowly oblong; lateral sepals reflexed 11. *M. atrorubens*

11b Plants green when fresh, pale to dark brown when dry:

13a Bracts leathery, venation not visible; petals purple 13. *M. rufescens*

13b Bracts membranous to thin-tissued, venation visible; petals lime-green:

14a Lip lorate; leaves linear-lanceolate 8. *M. reticulata*

14b Lip elliptic; leaves elliptic to lanceolate:

15a Lowest 2 (-3) leaves elliptic, spreading, sharply differentiated from the remaining leaves, flowering mostly in October 10. *M. comosa*

15b Leaves gradually smaller from the base to the apex of the stem; flowering mostly in December and January 10. *M. bolusiana*

(*M. ecalcarata*, *M. conferta*), and a line in which the spur becomes sharply curved, the inflorescence becomes relatively massive, and the flowers face downwards (*M. pygmaea*, *M. sabulosa*).

The *M. bracteata*/*M. densiflora* group is here considered as being ancestral. These two species are closely related, and may be separated by the shape of the spur and the galea. Both taxa are ecologically diverse and widespread in the Cape Flora. *M. bracteata* is ubiquitous in the area, and *M. densiflora* shows quite a remarkable degree of variation in the floral morphology (see below).

Both *Monadenia ecalcarata* and *M. conferta* are rare. *M. ecalcarata* is known from a single specimen, whereas the latter taxon is more widespread, but populations are very sparse. As both taxa show specializations not found in the other (the non-resupinate flowers in *M. ecalcarata* and the beetroot-red colouring in *M. conferta*), they cannot be placed in an ancestor-descendant relationship.

Monadenia sabulosa and *M. pygmaea* are restricted to the Cape Peninsula and the Caledon District, showing the False Bay disjunction in their distributions as recorded by Rourke (1972) for *Leucospermum hypophyllocarpodendron* subsp. *hypophyllocarpodendron* and Linder (1981b) for *Herschelia purpurascens*. However, as orchids are rather easily distributed by seed, it is suggested that this distribution pattern is the result of the distribution of available habitats, rather than of geological history, as suggested by Rourke (1972) for *Leucospermum hypophyllocarpodendron*. Although the group is quite distinctive, the species are clearly distinct. Although there is some overlap in the habitats of the species, *M. pygmaea* generally occurs on more rocky and more mountainous localities, whereas *M. sabulosa* is restricted to lowland sand-flats. Both taxa are generally recorded as flowering after fire.

1. *Monadenia ecalcarata* Lewis in J1 S. Afr. Bot. 14: 31 (1948). Type: Cape Province, Cape Peninsula, on damp rocky northern slopes of Constantiaberg, Lewis 1487 (SAM, holo.!).

Icon: J1 S. Afr. Bot. 14: 32, Fig. 2 (1948).

Plant 130 mm tall; tubers testicular, 10 mm in diameter; basal sheaths 2, hyaline, obtuse, up to 20 mm long; leaves linear-lanceolate, acute, erect and curved towards the stem, conduplicate, the longest at the base of the stem, 70 mm long, the upper grading rapidly into the floral bracts, densely imbricate; inflorescence a dense cylinder, 60 mm long and 15 mm in diameter with numerous imbricate flowers; ovaries slender, c. 10 mm long; bracts as tall as the flowers, lanceolate, acuminate. Flowers not resupinate, lime-green; dorsal sepal shallowly galeate at the base, narrowly oblong, obtuse, 4 mm long; petals obliquely narrowly oblong, obtuse, fleshy, 3 mm long; lip pendent, lorate, obtuse, 3–4 mm long; anther about 1 mm long; rostellum small, erect; stipe a nearly square, pulvinate.

Diagnostic features. Flowers with lateral sepals 4 mm long, spur obsolete, flowers not resupinate.

Flowering time: October.

This species is known from a single collection. It differs in too many characters from its nearest relations, *M. conferta* and *M. micrantha*, to be considered as an aberrant form. It is puzzling that an orchid should be so rare (Fig. 3).

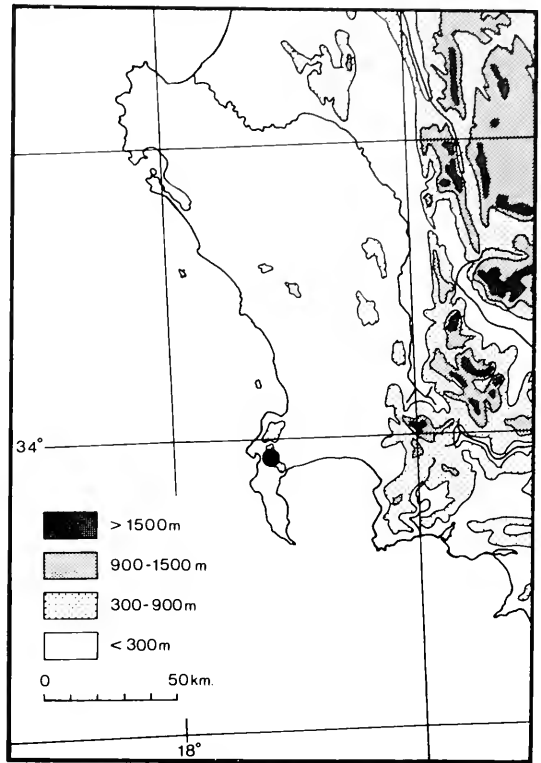


FIG. 3.—Distribution of *Monadenia ecalcarata*.

2. *Monadenia conferta* (H. Bol.) Kraenzl., Orch. Gen. Sp. 1: 810 (1900); Rolfe in Fl. Cap. 5, 3: 187 (1913). Type: Cape Province, Cape Peninsula, Raapenburg, Guthrie 725 (= *Bolus* 7097) (BOL, lecto.!, K!).

Disa conferta H. Bol., Icones Orch. Austro-Afr. 1: t. 28 (1893); Schltr. in Bot. Jb. 31: 212 (1901).

Icon: H. Bol., Icones Orch. Austro-Afr. 1: t. 28 (1893).

Plant slender, suffused with beetroot-red, 80–220 mm tall; tubers c. 10 mm long; leaves linear, acute, numerous, densely imbricate, the largest generally near the base of the stem, up to 70 mm long, erect, conduplicate, grading apically into the floral bracts; inflorescence dense, cylindrical, slender 30–130 mm long and 10 mm in diameter; ovaries 5–10 mm long; bracts as tall as or taller than the flowers, lanceolate, subacuminate, longer towards the base of the inflorescence. Flowers lime-green at anthesis, sepals soon turning beetroot-red; dorsal sepal shallowly galeate, rounded to obtuse, oblong, 2.5 mm long; spur sacate, 0.1–0.2 mm long; lateral sepals reflexed, oblong to narrowly oblong, rounded to obtuse, 2 mm long, shallowly concave, erect next to the rostellum; lip pendent, narrowly oblong, obtuse 2–2.5 mm long; another horizontal, 0.5–7 mm long, connective longer than the pollen masses, viscidium minute; rostellum 1 mm tall with large lateral lobes flanking the anther; stigma fused to the base of the rostellum. Fig. 4.

Diagnostic features. Flowers minute, lateral sepal 2.5 mm long; inflorescence dense, slender, cylindrical; spur obsolete.

Flowering time: (September–) October (–December).

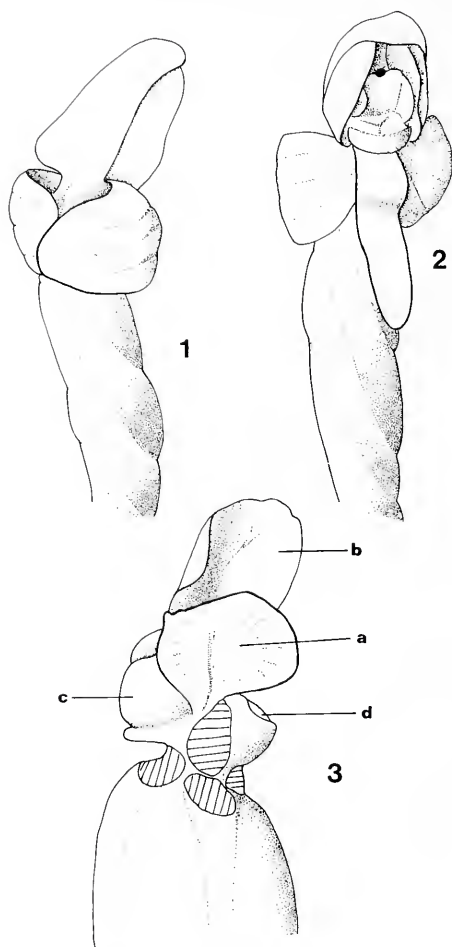


FIG. 4.—*Monadenia conferta*. 1, flower seen from behind, $\times 10$. 2, flower in front view, $\times 10$. 3, dissected flower: a, rostellum; b, petal; c, anther; d, stigma, $\times 20$. All drawn from Williams s.n. (BOL).

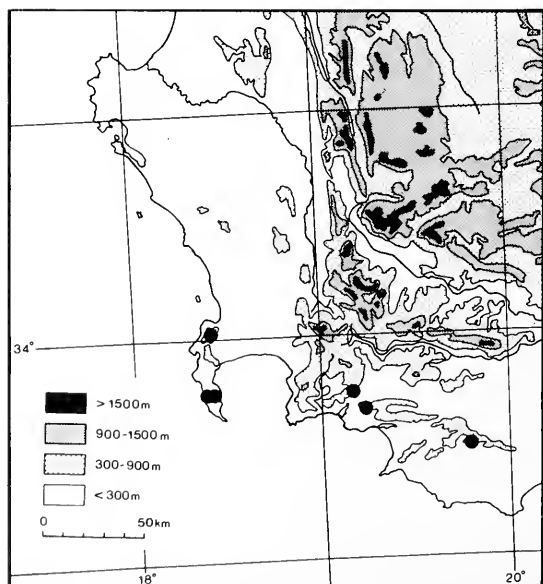


FIG. 5.—Distribution of *Monadenia conferta*.

Locally rare to common in the western Cape Province, occurring on seasonally damp to dry sand, rarely on rocky or gravelly slopes (Fig. 5).

CAPE.—3419 (Caledon): Koue Rivier Berge near Elim (—AD), Dec. 1896, *Schlechter 9618* (BM; BOL; G; K; P; PRE). 3418 (Simonstown): Buffels River Valley at Hangklip, on a rocky hillside, (—BD), Nov. 1945, *Barker 3925* (NBG); Cape Point Nature Reserve, Olifantsbos (—AD), Oct. 1955, *Lewis 4455* (SAM).

This species may readily be identified by the slender beetroot-red plant with minute spurless flowers.

Only one population has been studied in the field (*Linder 1528*, Caledon District, Babylon's Tower). Occasional to rare individuals occurred on dry scree slopes, flowering one year after a fire. Several collectors noted that the species flowered after fire. The altitude range of the species is from sea level to about 600 m.

Bolus (1893) described *Disa conferta* from two living specimens from different localities. These he cites as *Bodkin* in BOL 6231 from near Houw Hoek and *Guthrie* in BOL 7097 from Raapenburg on the Cape Peninsula. The latter collection is also in BOL under the number *Guthrie 725*. The Guthrie collection is also duplicated in Kew and is here selected as the lectotype.

3. *Monadenia sabulosa* (H. Bol.) Kraenzl., Orch. Gen. Sp. 1: 814 (1900); Rolfe in Fl. Cap. 5, 3: 195 (1913). Type: Cape Province, Cape Peninsula, Kenilworth, *Bolus 1374* (= 7104) (BOL, holo.!; BM!; G!; K!; P!; SAM!; UPS!; W!; ZT!).

Disa sabulosa H. Bol. in Icones Orch. Austro-Afr. 1 t. 27 (1893); Schltr. in Bot. Jb. 31: 207 (1901).

Icon: H. Bol., Icones Orch. Austro-Afr. 1: t. 27 (1893).

Plants 80–200 mm tall; leaves lanceolate, acute, sheathing at the base, semi-erect, the margins undulate, imbricate, the largest leaves near the base of the stem, up to 50 mm long, the apical leaves grading into the inflorescence; inflorescence dense, obovate, 30–70 mm long and up to 40 mm in diameter; ovaries c. 15 mm long; bracts as tall as the flowers, lanceolate, acute, green. Flowers with lime-green sepals and yellow petals and with a faint scent; dorsal sepal subspathulate to broadly obovate, falcate in sideview, the upper half shallowly galeate, obtuse, 10–15 mm long; spur pendent, flexuose near the base, slender, acute to retuse, 10–15 mm long; lateral sepals reflexed, oblong, rounded, 7–9 mm long, veins prominent; petals subobliquely oblong, the apex deeply and equally bifid, the lobes 2 mm long, petal 7–8 mm long, erect, twisted to face forwards; lip oblanceolate, obtuse, pendent, subfleshy, c. 6 mm long; anther pendent, 2 mm long, viscidium large, square, caudicles 1.5–2 mm long; rostellum lateral lobes partially flanking the anther, c. 2 mm tall; stigma flat, horizontal, 1 mm tall. Fig. 6.

Diagnostic features. Dorsal sepal subspathulate, facing downwards; spur geniculate; petals deeply bifid.

Flowering time: October (–November).

A rare, stout, greenish orchid, occurring on damp to dry sand, usually flowering after fires, in the western Cape Province (Fig. 7).

*In the treatment of each taxon only representative specimens have been cited. A full list of all specimens studied is given in the Appendix, pp. 361–363.

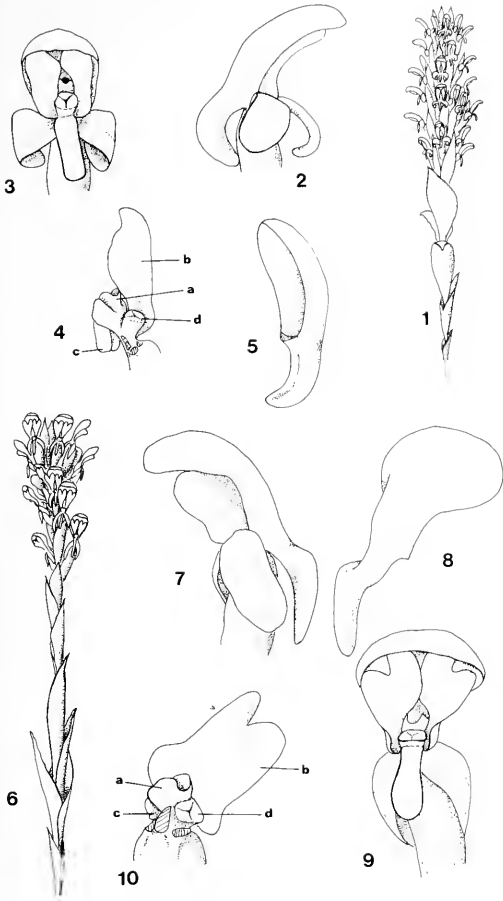


FIG. 6.—*Monadenia pygmaea* (1–5) and *M. sabulosa* (6–10). 1, plant of *M. pygmaea*, $\times 1$, from Stokoe s.n. (BOL). 2, flower in side view. 3, flower in front view. 4, dissection of flower. 5, dorsal sepal, (2–5 all drawn from Linder 1507, $\times 6$). 6, plant of *M. sabulosa*, $\times 0.5$, from Guthrie 1080. 7, flower in side view. 8, dorsal sepal in rear view. 9, flower in front view. 10, dissection of flower; a, rostellum; b, petal; c, anther; d, stigma. (7–10 from Linder 1508; 7–9 $\times 3$ and 10 $\times 5$.)

CAPE.—3318 (Cape Town): sandflats at Kenilworth near Wynberg (—CD), Oct. 1891, *MacOwan & Bolus* 1374 (BOL; SAM). 3418 (Simonstown): near Hangklip on road to Betty's Bay, on burnt ground (—BD), Oct. 1961, *Thomas in NBG* 56374 (NBG).

The type collection of this species was distributed under two different numbers — as *A. Bolus* in BOL 7104 (selected as lectotype) and as *A. Bolus* sub *MacOwan & Bolus* 1374.

Monadenia sabulosa may readily be distinguished from its allies by the deeply bifid petals, and from all the species in the genus by the sharp knee-bend in the spur and the subspathulate dorsal sepal.

A population studied at Betty's Bay (Linder 1508) occurred in sand among boulders on the lower slopes of the mountains, in a fire-break. Individuals occurred frequently, mostly in seasonally damp sand. Collectors' notes indicate that this species is most frequently collected after the climax vegetation has been removed (i.e. by fire or mechanical means) from sandy areas. The species ranges from near sea level to about 1 200 m altitude.

The conservation status of the species of the Cape Peninsula is not clear. The majority of collections are

from areas now heavily disturbed or built over. However, the status in the Betty's Bay area appears to be satisfactory. It must be noted that the species is restricted to the lower slopes of the mountains and the coastal flats, which are prone to invasion by various introduced *Acacia* species. In the long term, these localities will require active conservation.

4. *Monadenia pygmaea* (H. Bol.) Dur. & Schinz, *Consp. Fl. Afr.* 5: 111 (1894); Kraenzl. in *Orch. Gen. SP.* 1: 813 (1900); Rolfe in *Fl. Cap.* 5, 3: 190 (1913). Type: Cape Province, Cape Peninsula, Muizenberg Mountain, *Bodkin* in BOL 4970 (BOL, holo.!; G!; K!; SAM!).

Disa pygmaea H. Bol. in *J. Linn. Soc., Bot.* 20: 72 (1885); Schltr. in *Bot. Jb.* 31: 213 (1901).

Icon: H. Bol., *Icones Orch. Austro-Afr.* 3: t 37 (1913).

Plants 45–150 mm tall; leaves narrowly ovate, acute, imbricate, semi-erect, all equal in size, 15–20 mm long; inflorescence cylindrical, dense, 15–100 mm long, longer than the leafy part of the stem; ovaries c. 5 mm long; bracts taller than the flowers, lanceolate, acute, green. Flowers with lime-green lip and petals, green lateral sepals and rusty brown dorsal sepal and spur; dorsal sepal shallowly galeate, oblong, obtuse, 5–6 mm long and up to 2 mm deep; spur c. 2.5 mm long, cylindrical, retuse, falcately curved towards the ovary; lateral sepals patent with the apices reflexed, oblong, obtuse, 4 mm long; petals obliquely narrowly oblong with a small tooth to the rear, the apex shortly and acutely bifid, erect, twisted to face partially forwards, 4 mm long; lip subpendent, the apex reflexed, lorate, 3–4 mm long; anther pendent, 1 mm long; viscidium elongated with a dorsal groove; rostellum with small side lobes, 1 mm tall; stigma 0.3 mm tall, somewhat angled forwards. Fig. 6

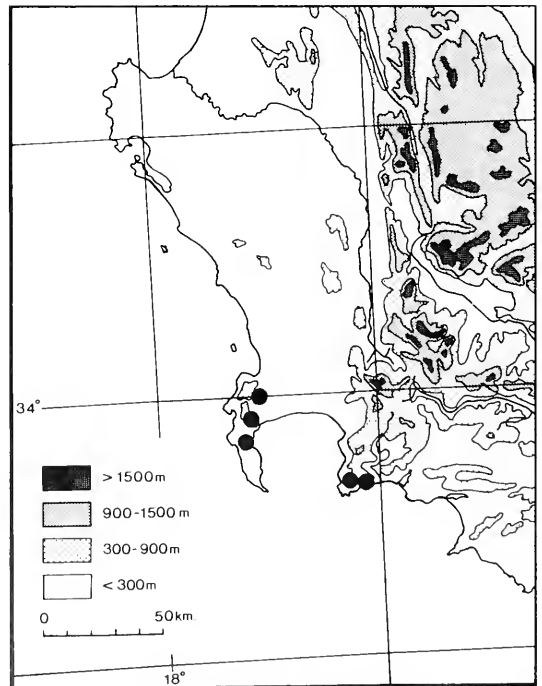


FIG. 7.—Distribution of *Monadenia sabulosa*.

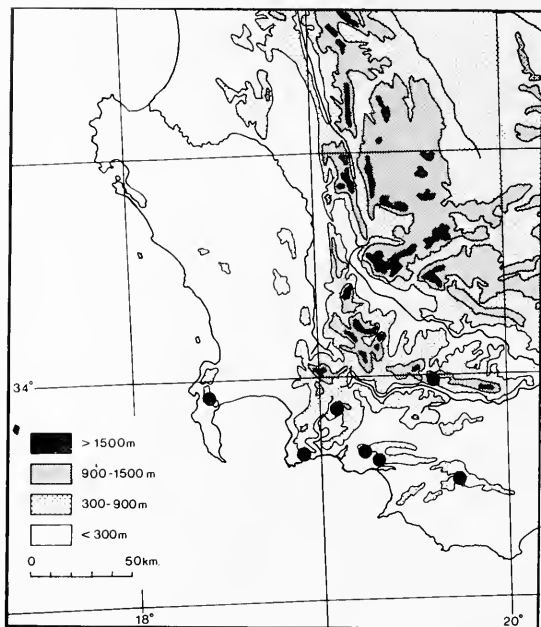


FIG. 8.—Distribution of *Monadenia pygmaea*.

Diagnostic features. Flowers small, lateral sepals 4 mm long; plants less than 150 mm tall, inflorescence longer than the leafy stem.

Flowering time: October and November.

Monadenia pygmaea occurs occasionally in small populations in sandy areas, often flowering after fire (Fig. 8).

CAPE.—3418 (Simonstown): Steenberg Plateau, burnt sandy slope near reservoir (—AB), Oct. 1945, *Lewis 1095* (SAM). 3419 (Caledon): Klein Riversbergen near Onrust (—AC), Nov. 1896, *Schlechter 9501* (BOL).

This species is allied to *M. sabulosa* by the bifid petals and the slight knee-bend in the spur, but may be distinguished from that species by the much smaller flowers and plants (sepals about 4 mm long). From the rest of the genus it may be separated on the inflorescence that is always longer than the leafy stem, the flowers that face downwards, and the short spur.

A population studied near Betty's Bay (*Linder 1507*) was found near *M. sabulosa* in sand in a recently cleared fire-break at the base of the mountain. Individuals occurred frequently in seasonally damp sandy areas. Other collectors also generally indicate a sandy substrate, except two collections from the Lebanon Forest Reserve, which are from dry rocky slopes, one with loose rocky sand. Several collections were made after fire. The altitude range of the species is from sea level to almost 1 000 m. The rainfall ranges from about 800 mm to over 1 500 mm in some localities, mostly restricted to the winter.

Although the majority of collections are from localities suffering from severe disturbance, the species has also been recorded from localities likely to have some long-term protection, such as the Lebanon Forest Reserve.

5. *Monadenia bracteata* (Swartz) Dur. & Schinz, *Consp. Fl. Afr.* 5: 111 (1894). Type: Cape of Good Hope, *Sparrman* s.n. (W, holo.).

Disa bracteata Swartz in *Vet. Acad. Handl.* 21: 211 (1800).

Monadenia micrantha Lindl., *Gen. Sp. Orch.* 357 (1838); *Kraenzl., Orch. Gen. Sp.* 1: 818 (1900); *Rolfe in Fl. Cap.* 5, 3: 190 (1913). *Disa micrantha* (Lindl.) H. Bol. in *Trans. S. Afr. phil. Soc.* 5: 142 (1888); *Schltr. in Bot. Jb.* 31: 213 (1901). Type: Knysna, *Ruigtevallei Drège 1261* (K, holo.; G!; P!; W!).

Disa praetermissa Schltr. in *Ann. Transv. Mus.* 10: 246 (1924). Type: Humansdorp, sandy grassland near Stormsriver, *Schlechter* s.n. (B, holo.).

Monadenia australiensis Rupp in *Austr. Orch. Rev.* 11: 70 (1946). Type: West Australia, Stirling Range, Youngs Siding, *Southerland* s.n. (PERTH, holo.).

Plants up to 300 (–500) mm tall; leaves linear-lanceolate, acute, imbricate, numerous, erect and usually curved inwards, the largest near the base, 40–120 mm long, grading apically into the floral bracts; basal sheaths hyaline, obtuse, 10–20 mm long; inflorescence cylindrical, imbricate, flowers numerous, 20–120 mm long; ovaries erect, 6–10 mm long; bracts shortly overtopping the flowers, rarely much taller than the flowers, narrowly ovate, acuminate. *Flowers* green with the sepals usually tinted maroon; dorsal sepal shallowly galeate, broadly oblong, obtuse to acute, 3–4 mm long and c. 1 mm deep, falcate in side view; spur shallowly triangular, pendent from the base of the galea, rounded to truncate, 3–4.5 mm long; lateral sepals patent with the apices usually reflexed, oblong, obliquely acute, 2.5–3.5 mm long; petals erect, partially included in the galea, broadly obtriangulate in outline, obliquely acute, 2–2.5 mm long, concave, venation strongly falcate; lip pendent narrowly oblong to lorate, often oblanceolate, 2–2.5 mm long; anther pendent, c. 1 mm long; rostellum with a large central notch, staminodes of variable size; stigma pulvinate. Fig. 10.

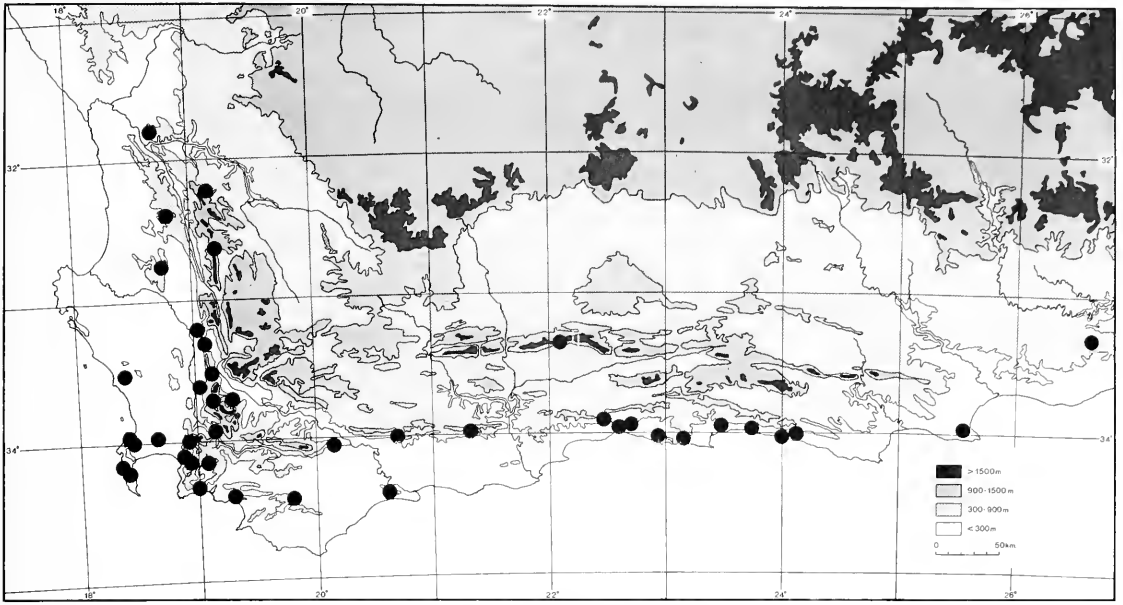
Diagnostic features. Flowers small, lateral sepals 2.5–3.5 mm long, spur pendent, 3–4.5 mm long, slender, rounded or truncate, inflorescence dense, cylindrical.

Flowering time: September–November.

Monadenia bracteata is a widespread and common little orchid (Fig. 9), that occurs frequently in wasteland areas, especially in areas of mild disturbance. In undisturbed vegetation it is widespread, but somewhat rarer. In Australia it has been recorded as a roadside weed.

CAPE.—3318 (Cape Town): Rondebosch, University of Cape Town football field (—CD), Sept. 1946, *Leighton 2079* (BOL). 3418 (Simonstown): Fish Hoek mountain, in shade under trees (—AB), Nov. 1944, *Lewis 823* (SAM). 3322 (Oudtshoorn): Saasveld, near George, in grassland at the forest edge (—DC), Oct. 1965, *Morze 2026* (BOL). 3323 (Willowmore): near Stormsriver mouth (—DD), Nov. 1894, *Schlechter 5965* (BM; G; K; W; Z).

The identity of *Disa bracteata* has led to much confusion. N. E. Brown applied the name to an illustration of what is clearly *Monadenia multiflora*. *Lindley* (1838) cited a plate of Brown (1818) as being *Disa bracteata*. *Bolus* (1888) discussed the problem of the identity of *D. bracteata*, indicating that it could not be confused with *Disa cylindrica* and that it is likely to be a *Monadenia*. He could not, however, trace a type specimen either in the Swartz or Thunberg herbarium. *Rolfe* (1913) was of the opinion that *D. bracteata* is *M. multiflora*, as 'It does not describe the cylindrical spur and linear lip of *M. micrantha* Lindl'. In Vienna I located a capsule containing several flowers and an inflorescence of *Monadenia micrantha*. The capsule was annotated '*Disa bracteata* Swartz scripsit'. The words '*Disa*' and '*Swartz scripsit*' were in a hand that I do not know, but '*bracteata*' is written in a hand closely resembling

FIG. 9.—Distribution of *Monadenia bracteata*.

that of Olof Swartz (*vide* Burdet, 1978). As there are several sheets of Swartz types at Vienna (Linder, 1981a), this is not exceptional, and might well be the type of *Disa bracteata*.

The type of *Disa praetermissa* has unfortunately been lost. However, from the protologue this name has to be included in the synonymy here, as the distinguishing characters mentioned by Schlechter (1924) (spur length and leaf shape) are quite variable in *M. bracteata*.

Monadenia bracteata is closely allied to *M. densiflora*, but may be distinguished from this species by the terete spur, which is generally as long as the dorsal sepal. In *M. densiflora*, the galea is often obovate, a state that never occurs in *M. bracteata*. From the rest of the genus these two species are separated by the small flowers (sepals less than 8 mm long) and spur as long as or shorter than the dorsal sepal.

This is by far the most common species of *Monadenia*, and occurs in a wide range of habitats, from dry sandy areas to gravelly mountain slopes, on damp clayey soils and in black turf sand. The altitude range of the species is from sea level to 1 500 m, and specimens have been collected in full sunlight and in shade. The rainfall regime over the distribution range varies from less than 800 mm p.a. to well over 1 600 mm, and from an all-year rainfall in the Knysna-Humansdorp area to several months of summer drought in the Clanwilliam area.

In undisturbed vegetation populations have a low density and individuals occur scattered over a large area. In disturbed conditions (road-cuttings) and fills, old fields, gravel pits, sport fields, etc.) large populations may be found. Over its whole distribution range, this species is well established as a pioneer.

M. bracteata has also been recorded from Australia, initially under the name *M. australiensis*, as it was thought to be indigenous to Australia (Rupp, 1946). Erickson (1965) noted that 'It was found to be most common on the roadsides, the usual lodging

place for immigrant plants ...' Pocock (1972) recorded this species only from the south-west of Australia, flowering in November. It was probably introduced accidentally to that continent.

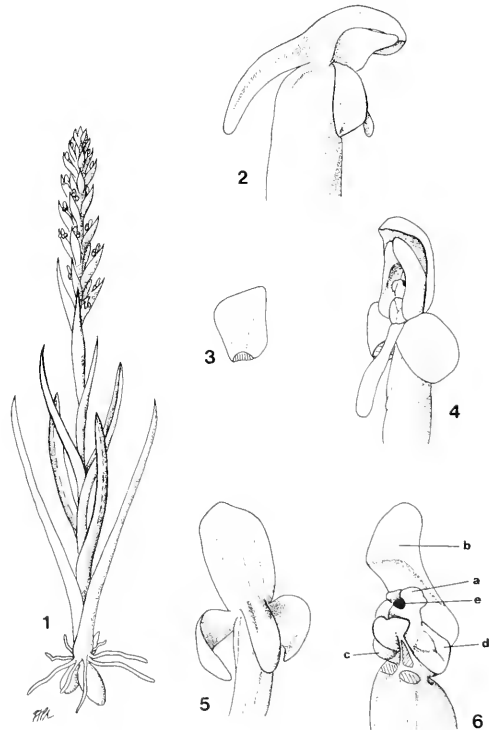


FIG. 10.—*Monadenia bracteata* (1–3) and *M. densiflora* (4–6). 1, plant of *M. bracteata*, $\times 0.5$, from Esterhuysen 12074. 2, flower in side view. 3 petal. (2–3 from Walters 508, $\times 5$.) 4, flower of *M. densiflora* in front view. 5, flower in rear view, showing the spur. 6, dissection of flower: a rostellum; b, petal; c, anther; d, stigma. (4–6 from Linder 1513, $\times 5$.)

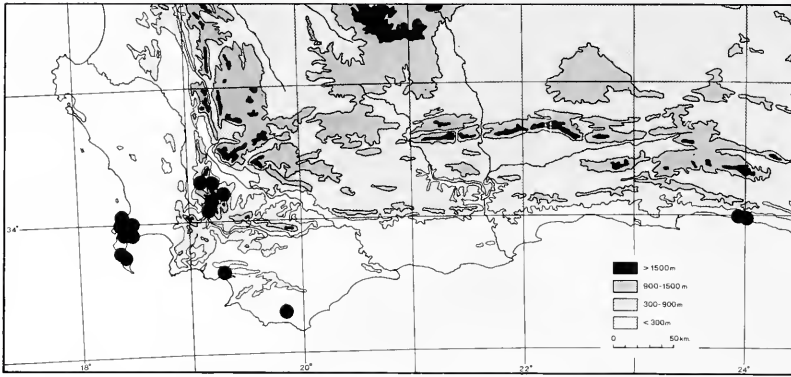


FIG. 11.—Distribution of *Monadenia densiflora*.

6. *Monadenia densiflora* Lindl., Gen. Sp. Orch. 357 (1838); Kraenzl., Orch. Gen. Sp. 1: 814 (1900). Lectotype: Cape of Good Hope, *Thom* s.n. (K, lecto!).

Disa densiflora (Lindl.) H. Bol. in J. Linn. Soc., Bot 25: 197 (1889).

Monadenia multiflora Sond. in Linnaea 19: 101 (1847); Kraenzl., Orch. Gen. Sp. 1: 811 (1900); Rolfe in Fl. Cap. 5, 3: 188 (1913). *Disa multiflora* (Sond.) H. Bol. in Trans. S. Afr. phil. Soc. 5: 140 (1888); Schltr. in Bot. Jb. 31: 215 (1901). Type: Cape Province, Cape Peninsula, Doornhoogte, Ecklon & Zeyher s.n. (S, holo.; K!; P!; W!).

Disa auriculata H. Bol., Icones Orch. Austro-Afr. 1: t. 77 (1896); Schltr. in Bot. Jb. 31: 214 (1901). *Monadenia auriculata* (H. Bol.) Rolfe in Fl. Cap. 5, 3: 189 (1913). Syntypes: Cape Province, Cape Peninsula, Guthrie s.n. (BOL!); Humansdorp, near Storms River, Schlechter 5958 (BOL!; BM!; G!; W!; Z!).

Icones: H. Bol., Icones Orch. Austro-Afr. 1: t. 77 (1896), as *Disa auriculata*: 3: t. 39 (1913), as *D. multiflora*.

Plants slender to robust, 75–195–350 mm tall; tubers up to 20 mm long; basal sheaths hyaline, obtuse to apiculate, 2–3, up to 40 mm long; leaves linear-lanceolate, acute, conduplicate, numerous, imbricate, 50–90–140 (–220) mm long, generally reaching to the base of the inflorescence and grading apically into the floral bracts; inflorescence slender cylindrical, 25–95–180 mm long, usually longer than the leafy shoot, flowers numerous, imbricate; ovaries 5–10 mm long, twisted; bracts as tall as or overtopping the flowers, generally longer towards the base of the inflorescence, narrowly ovate, acuminate. Flowers with dull green petals and lip, and rusty red to green sepals; dorsal sepal shallowly galeate, oblong, obtuse, erect or falcately curved forwards, 3–5 (–7) mm long and 0.5–1 mm deep; spur pendent from the base of the galea, triangular in cross-section, constricted at the base, apex obtuse to retuse, (1–) 2–3 (–4) mm long, shorter than the galea; lateral sepals oblong-ovate, sub-obtuse to rounded, spreading, apices reflexed, 3–5 (–7) mm long; petals erect, narrowly oblong, subfalcate, 2.5–5 (–7) mm long, rounded to rarely acute, the apical 1/3 fleshy; lip pendent, narrowly oblong to oblanceolate, rounded, 2.5–5 (–7) mm long, apex fleshy; anther pendent, c. 0.8 mm long; rostellum with a deep notch for the single viscidium, viscidium flanked by two flat projections; stigma horizontal, unequally three-lobed. Fig. 10.

Diagnostic features. Flowers small, lateral sepals 3–5 (–7) mm long, spur shorter than the galea, 2–4 mm long, triangular in cross-section, somewhat constricted at the base; plants 75–350 mm tall.

Flowering time: (September–) October (–December).

Monadenia densiflora is a widespread, but usually not common, species, occurring usually in sandy places, but also in a wide range of other habitats (Fig. 11).

CAPE.—3318 (Cape Town): Table Mountain, Groene Kloof, 600 m (–CD), Nov. 1897, *Galpin* 4612 (PRE), 3418 (Simonstown): Constantiaberg, slopes above Baviaans Kloof (–AB), Oct. 1947, *Lewis* 1833 (SAM); Krom River (–AB), Oct. 1945, *Compton* 17486 (NBG). 3319 (Worcester): Wemmershoek Peak, 1 650 m (–CC), Dec. 1944, *Lewis* 850 (SAM). 3323 (Willowmore): at Stormsriver Mouth (–DD), Nov. 1978, *Linder* 1903 (BOL).

Monadenia densiflora Lindl. was based on two syntypes at Kew, namely *Thom* s.n. and *Drège* 8288. According to Article 9.2 of the I.C.B.N. (1978), the element most closely resembling the protologue has to be selected as the lectotype. *Thom* s.n. most closely resembles the protologue. ‘Calcere pendulo filiforme antice alato’ and ‘labello lineari-spathulato carnosio’ can only refer to this element, whereas ‘petalis galea duplo brevioribus’ refers to *Drège* 8288. N. E. Brown in a note on *Thom* s.n. wrote that the description of *M. densiflora* was based on this specimen, but Rolfe (1913) effectively lectotyped the name *M. densiflora* by attaching the *Thom* specimen (*Thom* 732) to that species and referring *Drège* 8288 to *M. physodes*. This lectotypification should be followed.

This highly variable species has small flowers (sepals 3–5 (–7) mm long) with a spur shorter than the galea. It may be separated from the closely related *M. bracteata* by the relatively short spur which is triangular and constricted at the base.

This species has a peculiarly disjunct distribution, with the vast bulk of the collections known from the western Cape Province, and a few rare collections from the Tsitsikamma coastline between Humansdorp and Knysna. As discussed above, there is some morphological differentiation between these two centres.

In the western Cape, this species occupies a wide range of habitats. It has been recorded from sand near sea level, at Olifantsbos in the Cape Point Nature Reserve, from the summit of Table Mountain, and from rock ledges in the Wemmershoek Mountains. The altitude range of the species is from sea level to over 1 600 m. In general, it appears to be restricted to slightly damp areas, and has often been collected after fires. It does not appear to be common in any of these habitats. The macro-climatic conditions vary from all year rainfall in the Knysna area, to summer drought conditions on the Cape Flats. In

the mountains of the western Cape, it often occurs in the south-eastern cloud zone.

Monadenia multiflora has generally been recognized as a distinct species. Sonder (1847) clearly distinguished it from *M. bracteata* by the larger flowers and shorter spur. However, *M. auriculata* has never been satisfactorily separated from *M. multiflora*. Bolus (1896) stated 'It comes near to *D. multiflora*, *mihi*, in its flowers, but the spike is always slenderer, and the inflorescence usually less dense'. Schlechter (1901) claimed that *D. auriculata* may easily be recognized by 'the more slender habit, smaller flowers, more helm-shaped dorsal sepal and the rostellum'. Rolfe (1913) used the relative lengths of the spike and the leafy shoot to separate the two putative taxa. Lewis (1950) separated the taxa on the width of the spike and the shape of the spur. A careful analysis of all the available material, as well as field studies in the various localities where the types were collected, showed that the two taxa could not be maintained as distinct from each other and *M. densiflora*.

Monadenia densiflora is rather variable with respect to flower size, and the shapes of the petals and the spur. Although the inflorescence is generally longer than the leafy shoot, the ratio is often reversed. Spur length varies from 1 mm (Barker 3893) to 4 mm (Page in BOL 16232) and spur shape from a rounded apex to an emarginate apex. There is some geographical pattern to flower size. Collections from the Tsitsikamma coastal flats have the smallest flowers (lateral sepal c. 3 mm long, Linder 1903), whereas collections from the summit of Table Mountain on the Cape Peninsula show the largest flowers (Lewis 1107). One of the syntypes of *D. auriculata* (Schlechter 5958) is representative of the small-flowered Tsitsikamma form, whereas the lectotype of *M. densiflora* is typical of the large-flowered form from Table Mountain. The type of *M. multiflora*, Ecklon & Zeyher s.n., is from the more common intermediate size range (lateral sepals c. 3,4 mm long).

Sect. **Kamiesbergenses** Linder, sect. nov., calcaris sepalis dorsalis aequanti, sepalis c. 7 mm longis, inflorescentia laxa dignoscenda.

Spur about as long as the dorsal sepal; flowers medium sized, sepals about 7 mm long; inflorescence lax.

Type species: *Monadenia macrostachya* Lindl.

The sole species in this section, *M. macrostachya*, could be placed into any of the other three sections, as it is closely related to *M. densiflora*, *M. reticulata* and *M. brevicornis*. However, in the cladistic analysis followed here, it would appear to be best placed in a position linking the other groups, and possibly ancestral to them. If the other three groups were to be recognized as being distinct sections, this species would also have to be placed into a section by itself.

This analysis would imply that the present distribution of *M. macrostachya* is only a relic of a more extensive older distribution. If this is correct, it is certainly interesting that the relic should be in an outlier of the Cape Flora, where the species richness is relatively low.

7. ***Monadenia macrostachya* Lindl., Gen. Sp. Orch. 357 (1838); Kraenzl., Orch. Gen. Sp. 1: 812 (1900), excl. syn.; Rolfe in Fl. Cap. 5, 3: 189 (1913).** Type: Cape Province, Namaqualand, Rooiberg. Drège 8289 (K, holo.; G!; K!).

Disa macrostachya (Lindl.) H. Bol. in J. Linn. Soc., Bot 25: 197 (1889); Schltr. in Bot. Jb. 31: 209 (1901), excl. syn.

Plant slender, 300 mm tall; leaves imbricate, the lower 4–8 lorate, acute, erect, conduplicate, up to 130 mm long and 20 mm wide, remaining leaves mostly sheathing, grading into the floral bracts; inflorescence lax with several flowers, up to 200 mm long; ovaries c. 10 mm long; bracts as tall as the flowers, ovate, acuminate, probably dry. *Dorsal sepal* erect, narrowly oblong, acute, 8 mm tall and galea 1,5 mm deep; spur pendent from the base of the galea, somewhat inflated, obtuse to retuse, 6–8 mm long and about 2 mm in diameter, straight; lateral sepals reflexed, oblong, obtuse, c. 7 mm long; petals obliquely narrowly ovate, very acute, 6 mm long, erect; lip pendent, lorate, obtuse, 6 mm long; anther semipendent, 1,5 mm long; rostellum erect, tall; stigma on a 2 mm tall pedicel.

Diagnostic features. Dorsal sepal 8 mm long, spur subclavate, retuse, as long as the dorsal sepal, bracts dry, basal leaves lorate, erect, acute, cauline leaves mostly sheathing.

Flowering time: ? September.

This species is only known from two collections: the type collection probably made in about 1835 by Drège; and from a plant past flowering, collected by me in 1977 (Fig. 12). The above description was prepared from the meagre material available, and upon receipt of further material may well be found to be wanting.

Although *M. macrostachya* is clearly distinct, it is related to several of the major groups in *Monadenia*, and may be regarded phylogenetically as a relic that links these three groups together (Fig. 2).

Following Bolus (1911) and Schlechter (1901) in most herbaria *Monadenia macrostachya* and *M. reticulata* are regarded as synonymous. In this treatment *M. reticulata* is regarded as a distinct species.

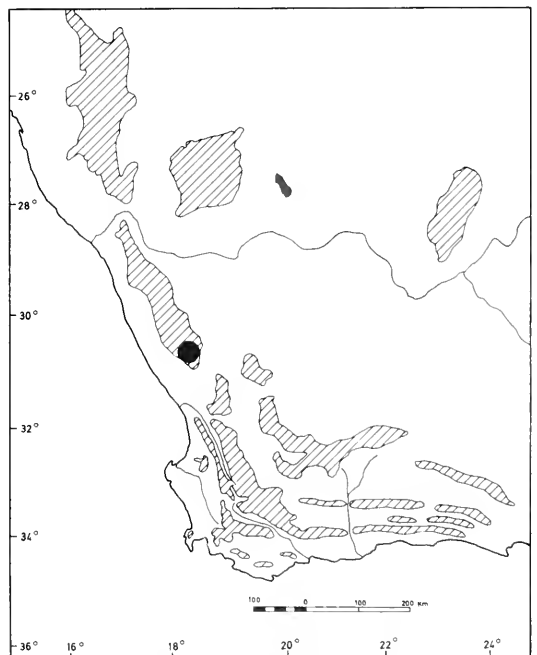


FIG. 12.—Distribution of *Monadenia macrostachya*.

A single small population of this species was located by the author in the Kamiesberg on the Rooiberg. The plants occurred in dry stony soil near a stream, and had been heavily grazed by sheep. There might well be more populations, as the mountains have not been properly explored.

Sect. *Tenuicornes* Linder, sect. nov., calcari tenui, sepalis dorsalibus longiore, sepalis 6–10 mm longis, inflorescentia laxa dignoscenda.

Spur slender, longer than the dorsal sepal; flowers medium sized, sepal 6–10 mm long; inflorescence lax.

Type species: *Monadenia ophrydea* Lindl.

This rather distinct section includes six species: *M. reticulata*, which is closely related to *M. macrostachya*, in which it has been included by some botanists; *M. rufescens*, with a relatively short spur and an elongated viscidium; *M. bolusiana* and *M. comosa*, with green petals and the stigma on a tall stipe; and *M. ophrydea* and *M. atrorubens* in which the plants are suffused with beetroot-red. The section may be distinguished from sect. *Densiflorae* and sect. *Kamiesbergenses* by the spur always being longer than the dorsal sepal, and from sect. *Monadenia* by the slender spur.

Both the *M. comosa* and the *M. ophrydea* groups may be derived from *M. reticulata*. Consequently, this species is treated as being ancestral in the section. Other evidence in favour of the ancestral position of this species is its wide distribution and large range of habitats. It is also closely related to *M. macrostachya*.

M. rufescens is clearly related to *M. reticulata* by the slender spur and the shape of the petals, but may readily be distinguished by the three-dimensional shape of the flowers, the dense tissue of the bracts which do not show the venation, and the elongated viscidium. It appears as if this species may have evolved a peculiar pollination syndrome. Although *M. rufescens* is essentially restricted to the western Cape Province, it has been collected from a wide range of habitats.

Within the *M. comosa* complex three groups might conveniently be recognized. The differences between these groups are given in Table 2. The characters listed in the table are approximations, as several are rather difficult to quantify e.g. variation in leaf shape and the habitats. No difference in the floral structures among the groups has been detected.

The three groups behave like ecotypes. Group one occurs almost invariably in rock crevices, usually in

shady places. Group three generally grows in full sunlight, usually on the upper ridges of mountains. Various populations occur in a wide range of habitats: deep sand (Ebersohn 151), footpaths (Linder 1672) and in rock crevices and ledges (Linder 1748). These two groups occur in the Langeberg and in the mountains between Caledon and Clanwilliam. Group two occurs on the summit of the Swartberg near Oudtshoorn, at a high altitude, in a zone receiving the bulk of the rain in the summer months. It grows in a habitat similar to that of Group three.

Groups one and three behave like distinct species. The ranges of these two groups are sympatric but, although populations of the two groups occur on the same mountain, the plants occupy different habitats, and interbreeding is prevented by allochronic flowering. Morphologically, individuals can be placed into these two groups on the basis of the leaf structure and the colour of the vegetative parts of the plants, both in the fresh and dried state.

Group two does not occur sympatrically with groups two and three, and its biological role can therefore not be determined on the basis of its interaction with closely related populations. Morphologically, the populations are quite variable, with the majority of individuals rather similar to group one, but with the variation ranging almost to that typical of group three.

Taxonomically the *M. comosa* complex may be treated in several ways:

1. As a variable species with three infraspecific taxa. However, groups one and three behave as distinct species.
2. As two distinct species, with group two recognized at infraspecific level in either of the two species. However, group two is intermediate between the two species, and such a treatment implies that either group two arose by secondary convergent evolution, or that group one arose by secondary divergence from group two.
3. As two distinct species, with group two recognized as an ancient hybrid complex between the two species. This would account for the extraordinary range of variation in the populations assigned to group two. Hybridization on the Swartberg could be accounted for by the delay of flowering of group one, leading to synchronous flowering. This would lead to the present situation, where parents, hybrids and the results of introgression can no longer be separated. This interpretation of group two would also strengthen the notion that groups one and three represent biological species.

TABLE 2.—Groups recognized within *M. comosa* s.l.

Character	Group one	Group two	Group three
Leaves	Basal two leaves spreading, distinct from rest	Leaves variable, basal leaves generally larger	Basal leaves grading gradually into upper leaves
Flowering (months)	(9–) 10 (–11)	12	(10–) 12–1
Habitat	Shady ledges	Full sun in rocks	Full sun on mountain summits

The third treatment is followed in this study.

Although the *M. comosa* complex is closely related to *M. reticulata*, it may be separated from this species by the higher stigma and somewhat longer spur. Both species of the group are best regarded as specialized derivatives from *M. reticulata*.

Monadenia ophrydea and *M. atrorubens* are also very closely allied and have frequently been confused. There are numerous small differences between the species, most of which are rather difficult to observe on dried material and have at least some exceptions. Only the rostellum height/stigma height ratio appears to be a constant differential character. The differences between the two species are listed in Table 3.

TABLE 3.—Morphological differences between *M. atrorubens* and *M. ophrydea* (note that few collections have all these characters)

<i>M. atrorubens</i>	<i>M. ophrydea</i>
Rostellum as tall as stigma	Rostellum twice as tall as stigma
Lateral sepals completely reflexed	Lateral sepals not or barely reflexed
Dorsal sepal narrowly oblong	Dorsal sepal oblong-obovate
Lateral sepals deep purple	Lateral sepals almost white
Caudicles shorter than the pollinarium	Caudicles longer than the pollinarium
Lip oblong to narrowly oblong	Lip narrowly elliptical to lorate
Lip 5–7 (–8) mm long	Lip 8–10 mm long

The morphological differences between the species are correlated with ecogeographical differences. *M. atrorubens* occurs on the west coast of the western Cape Province, and extends southwards to Houw Hoek in the Caledon District, whereas *M. ophrydea* extends from Table Mountain on the Cape Peninsula eastwards to Humansdorp. *M. atrorubens* grows mainly on deep sand, in areas in which there is almost no precipitation in the summer months, whereas *M. ophrydea* is generally found on mountain slopes in shallower stony sand, in areas where there is at least some rainfall in the summer months. Flowering in *M. atrorubens* peaks in September, while in *M. ophrydea* it peaks in October.

This group appears to be derived from *M. reticulata*, and is morphologically very similar to it. The beetroot-red colour of the plants appear to be a single-gene factor, as several individuals have been collected in which the red coloration is absent. Such individuals are difficult to distinguish from *M. reticulata* when they are dried.

8. *Monadenia reticulata* (H. Bol.) Dur. & Schinz, Consp. Fl. Afr. 5, 3: 111 (1894); Kraenzl., Orch. Gen. Sp. 1: 816 (1900); Rolfe in Fl. Cap 5, 3: 193 (1913). Type: Cape Province, Cape Peninsula, Constantiaberg, Bodkin in BOL 4988 (BOL, holo.!). K!).

Disa reticulata H. Bol. in J. Linn. Soc., Bot. 22: 75 (1885); Schltr. in Bot. Jb. 31: 209 (1901), excl. syn.

Icones: H. Bol., Icones Orch. Austro-Afr. 2: t. 88 (1911); 3: t. 41 (1913), as *Disa macrostachya*.

Plants 80–400 mm tall; leaves generally linear-lanceolate, rarely narrowly oblong, acute, imbricate,

erect, the lower the longest, up to 150 mm long, gradually grading into the upper leaves that are almost completely sheathing, grading into the floral bracts; inflorescence cylindrical, generally dense with numerous flowers, 30–150 mm long; ovaries c. 10 mm long; bracts reaching to the top of the flowers, narrowly ovate, acuminate, the reticulate venation clearly visible on dried material. Flowers lime-green, occasionally with some maroon tinting or mottling on the petals or sepals, scent strong, soapy; dorsal sepal shallowly galeate, oblong, obtuse, somewhat curved forwards, 7–8 mm long; spur pendent from the base of the galea, slender, acute, longer than the galea, 10–20 mm long and c. 1 mm in diameter; lateral sepals oblong, rounded, 6–7 mm long; petals obliquely narrowly ovate to rarely narrowly oblong, apically obliquely retuse to rounded, the broad base of the petals enclosing the anther, the apex twisted to face forwards, 5–6 mm long; lip pendent, lorate to rarely narrowly oblanceolate, acute to rarely rounded, 4–6.5 mm long; anther semipendent, 1.5 mm long; rostellum simple, 1 mm tall; stigma simple, not as tall as the rostellum.

Diagnostic features. Flowers with the lateral sepals 6–7 mm long; spur 10–20 mm long, slender, acute; lip lorate; bracts with an obvious reticulate venation; leaves generally linear-lanceolate, erect, about 8.

Flowering time: November and December.

Monadenia reticulata occurs occasionally in seasonally damp places in the western Cape Province, often after fire, between sea level and 1 700 m. It also extends eastwards along the mountains to George (Fig. 13).

CAPE.—3318 (Cape Town): Table Mountain, 700 m (–CD), Dec. 1879, Bolus 4542 (BOL). 3320 (Montagu): Grootvadersbosch, Heidelberg (–DD), Dec. 1958, Barker 8838 (NBG). 3322 (Oudtshoorn): Montagu Pass, 600 m (–CD), Nov. 1894, Schlechter 5791 (BOL; Z).

This species has for some time been confused with *M. macrostachya* (Schlechter, 1901; Bolus, 1913), but it may be separated by the spur which is longer than the dorsal sepal, the laxer inflorescence and the narrower leaves. From the rest of the *Monadenia* species with slender spurs it is distinct by the papery bracts, which clearly display the venation in the dried state, the greenish flowers and the erect linear-lanceolate leaves.

The collections all appear to be from sandy soil derived from Table Mountain Sandstone. Most of the collections are from areas where at least some precipitation occurs in the summer months, even if only from cloud derived from south-east winds.

9. *Monadenia comosa* Reichb. f. in Linnaea 20: 687 (1847); Kraenzl., Orch. Gen. Sp. 1: 813 (1900); Rolfe in Fl. Cap. 5, 3: 194 (1913). Type: Cape of Good Hope, Gueinzus s.n. (W, holo.!).

Disa comosa (Reichb. f.) Schltr. in Bot. Jb. 31: 206 (1901); H. Bol., Icones Orch. Austro-Afr. 3: t. 43 (1913).

Monadenia rufescens Lindl., Gen. Sp. Orch. 356 (1838), non Thunb. *Disa affinis* N. E. Br. in Gdnrs' Chron. 24: 402 (1835), nom. nov. Lectotype: Cape Province, near Genadendal, Drège 1252 (K, holo.!).

Icon: H. Bol., Icones Orch. Austro-Afr. 3: t. 43 (1913), as *Disa comosa*.

Plants erect or subflexuose, 80–300 (–600 mm tall; tubers slender cylindrical, up to 50 mm long, basal sheaths hyaline, obtuse, 1–2; leaves variable the basal 2 (–3) elliptic to rarely narrowly elliptic, ob-

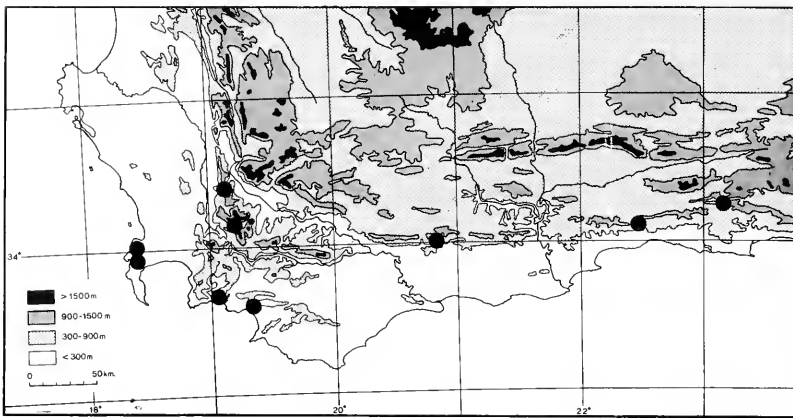


FIG. 13.—Distribution of *Monadenia reticulata*.

tuse, semi-erect, 30–70–120 (–170) mm long, the remaining leaves closely sheathing the stem, acute, lax to imbricate, similar to the floral bracts; inflorescence slender, usually lax, 40–150 mm long, with 1–20 flowers; ovaries erect, 15–20 mm long; bracts slightly shorter than the ovaries, narrowly ovate to rarely ovate, acute to acuminate, venation reticulate and visible. Flowers lime-green, occasionally tinted red; dorsal sepal erect to somewhat curved forwards, shallowly galeate, oblong, obtuse to rounded, 9–11 mm tall and c. 1 mm deep; spur pendent from the base of the galea, slender cylindrical, acute, adpressed to the ovary, 17–24 mm long and c. 1.5 mm in diameter; lateral sepals patent to reflexed, obliquely oblong-ovate, obtuse, 6–7 mm long; petals obliquely ovate-narrowly oblong, obliquely retuse to emarginate, 6–8 mm long, the broad basal part enclosing the anther and the narrower apical part curved forwards; lip elliptic, decurved, obtuse to acute, subfleshy, 6–8 mm long; anther semipendent, 2 mm long; rostellum simple, 2 mm tall; stigma as tall as the rostellum. Fig. 14.

Diagnostic features. Spur slender, acute, 17–24 mm long; bracts with the venation visible; stigma as tall as the rostellum; petals lime-green; basal two leaves spreading, the remaining leaves closely sheathing the stem.

Flowering time: (September–) October (–November).

A widespread and often common green flowered orchid in rock crevices and on ledges (Fig. 15).

CAPE — 3319 (Worcester): Slab Peak, Michell's Pass (–BA), Oct. 1941, *Compton 11955* (NBG). 3318 (Cape Town): rock crevices on Table Mountain (–CD), Oct 1883, *MacOwan & Bolus 170* (BM: BOL; G; K; P; W; ZT). 3419 (Caledon): Kanonkop, above Greyton, 1500 m (–BA), Jan. 1964, *Oliver s.n.* (BOL). 3322 (Oudtshoorn): summit of Swartbergpas (–AC), Dec. 1977, *Linder 1740* (BOL).

Reichenbach described *M. comosa* from a Gueinzus collection. In the Reichenbach collection at Vienna there is a single specimen of *M. comosa* collected by Gueinzus, but it is labelled '*Monadenia rufescens*'. However, this annotation is not in Reichenbach's hand, and *M. rufescens* is the name that Lindley (1838) applied to this taxon. This sheet is likely to be the holotype.

Lindley mistook the identity of Thunberg's *Satyrion rufescens*, and described it as being: 'foliis radicalibus binis oblongis, caule vaginato', a character unique to *M. comosa*. Of the two collections cited by Lindley, one, *Drège 1252*, fits his description, and the other is referable to *Monadenia rufescens* (Thunb.) Lindl. in the correct sense.

Reichenbach proposed the name *M. comosa* for the species, but he did not refer to Lindley's work. The name is therefore not a *nomen novum*, and the type is the Gueinzus collection. In 1885 N. E. Brown proposed *Disa affinis* as a *nomen novum* for *M. rufescens* Lindl. non Thunb., apparently unaware of the identity of *M. comosa* Reichb. f. This confusion was resolved by Durand & Schinz (1894).

Monadenia comosa belongs to the group of species in *Monadenia* with long slender spurs. It may be separated from the other species in this group by the two or three large spreading narrowly ovate basal leaves, the dry papery floral bracts and the pale green flowers.



FIG. 14.—*Monadenia comosa*, from Esterhuysen 16200, $\times 0.5$.

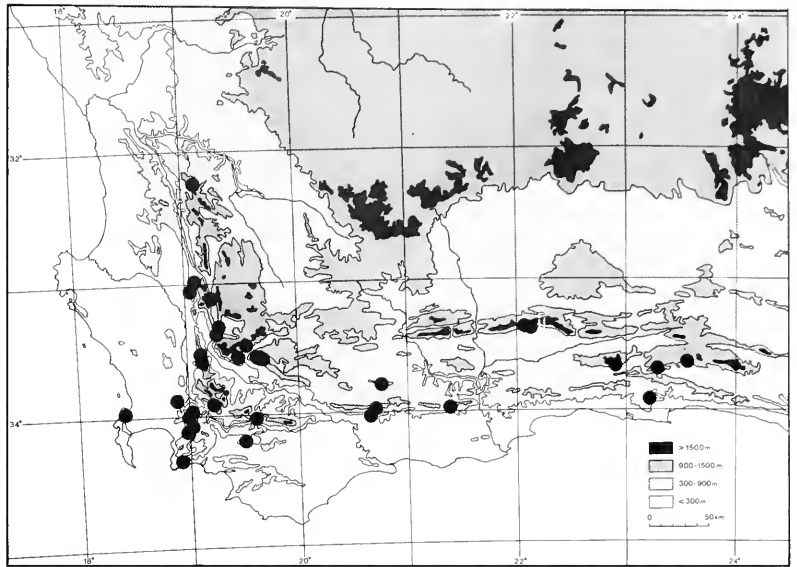


FIG. 15.—Distribution of *Monadenia comosa*

This species is widespread in the mountains of the western and southern Cape Province, where it occurs almost exclusively in crevices and on ledges on rocks and cliffs, often in half-shade. A few collections are from talus slopes e.g. *Linder* 1601. In general, populations consist of numerous individuals, often forming almost monospecific associations on rock ledges. On the summit of the Swartberg at Oudtshoorn, plants occur in gravelly soil (*Linder* 1740).

The altitude range of the species is from near sea level to 1 600 m, although the majority of the collections are from below 1 000 m. Rainfall over the distribution range varies considerably from an all-the-year rainfall in the Knysna area, to summer drought conditions in the western Cape area.

10. *Monadenia bolusiana* (Schltr.) Rolfe in Fl. Cap. 5,3: 194 (1913). Type: Cape Province, Cape Peninsula, Table Mountain, *Bodkin* in BOL 4903 (BOL, lecto.!: K!).

Disa bolusiana Schltr. in Bot. Jb. 24: 426 (1898); Schltr. in Bot. Jb. 31: 207 (1901).

Icon: H. Bol., Icones Orch. Austro-Afr. 2: t. 90 (1911).

Plants erect, (100–) 200–300 mm tall; basal sheaths hyaline, obtuse; leaves imbricate, the lower 2–5 narrowly oblong, acute, semi-erect, flat, the largest 50 (–70) mm long, grading gradually into the sheathing, narrowly ovate, acute upper leaves; inflorescence subimbricate, occasionally secund, 30–130 mm long and with 2–25 flowers; ovaries 15–20 mm long, erect; bracts about as long as the ovaries, narrowly ovate, acute, the reticulate venation usually visible. Flowers lime-green, occasionally tinted red; dorsal sepal erect, curved forwards, shallowly galeate, oblong, obtuse to rounded, 8–11 mm long and c. 1 mm deep; spur pendent from the base of the galea, slender, acute, 16–22 mm long and about 1 mm in diameter; lateral sepals reflexed, oblong, rounded, 6–8 mm long; petals obliquely ovate-narrowly oblong, obliquely emarginate, 6–8 mm long, the broad basal part enclosing the anther, the narrower apical part erect; lip patent or recurved,

elliptic, obtuse to acute, subfleshy, 5–7 mm long; anther semipendent, 1.5–2 mm long; rostellum erect, 1.5 mm tall; stigma as tall as rostellum. Fig. 16.

Diagnostic features. Spur slender, acute, 16–22 mm long; petals lime-green, stigma as tall as the rostellum; lower cauline leaves larger than the upper, but gradually grading into them; plants flowering in December and January.

Flowering time: (October–) December–January.

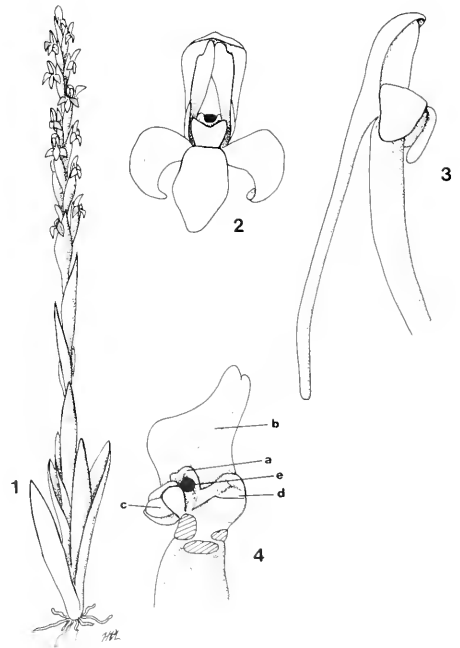


FIG. 16.—*Monadenia bolusiana*. 1, whole plant, from Esterhuysen 9780, $\times 0.5$. 2, flower in front view, $\times 3$. 3, flower in side view, $\times 2$. 4, dissection of flower; a, rostellum; b, petal; c, anther; d, stigma; e, viscidium, $\times 5$. 2–4 from *Linder* 1748.

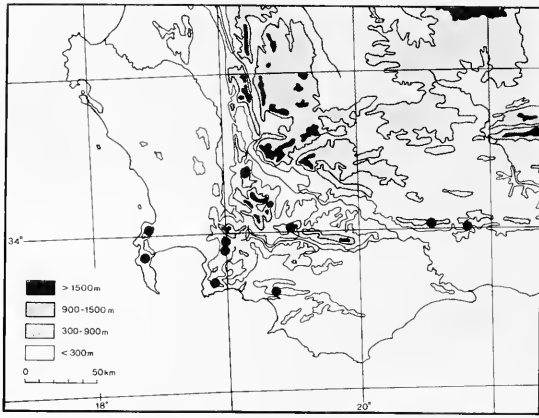


FIG. 17.—Distribution of *Monadenia bolusiana*.

Monadenia bolusiana is a small dark green to even purplish herb that occurs occasionally to frequently in exposed gravelly soil on the summit of the mountains in the western Cape Province (Fig. 17).

CAPE. — 3419 (Caledon). Betty's Bay, Harold Porter Nature Reserve, east slope of Voorberg, 200 m (—BD), Nov. 1970, *Eber-son* 151 (NBG). 3320 (Montague): Strawberry Hill (—DD), Dec. 1957, *Stokoe* in *CH* 9904 (NBG).

Schlechter (1898) cites three collections after his description of *Disa bolusiana*: *Zeyher* 1570 and *Bolus* 4903 from Maclear's Beacon on Table Mountain and *Schlechter* s.n. from the Langeberg above Zuurbraak near Swellendam. It is likely that these collections were in Schlechter's herbarium in Berlin that was destroyed in World War II. In BOL there is an excellent duplicate of *Bolus* 4903, and that is selected here as the lectotype. However, there are two collections under that number. The first one is a *Bodkin* collection, made in January 1883, while the second is a *Scully* collection, made in January 1884. The illustration for the *Icones* was made from the second collection, while Schlechter specified the first collection as the type ('*Bolus* n. 4903, bluehend im Januar 1883').

This species is closely allied to *Monadenia comosa* by virtue of the long slender spur, green flowers and papery bracts. It may be separated from this species by the numerous cauline leaves, the purplish colour of the plants and the flowering season (November to January).

Monadenia bolusiana occurs mostly in the full sunlight on the summit ridges of mountains, in shallow gravelly soils, often in footpaths and other disturbed areas. At present there are rather few herbarium records of this species, but this might be due to undercollecting in these more or less inaccessible localities. Fieldwork has revealed it to occur at least occasionally, and possibly even frequently and widespread, in the summit zones of the ridges. The altitudinal range of the species is from 200 m in the Betty's Bay area to over 1 200 m in the Langeberg and Hottentots Holland Mountains. Over the whole range there is a certain amount of moisture available in the summer months from condensation from the 'south-easter' clouds.

11. *Monadenia atrorubens* (Schltr.) Rolfe in Fl. Cap. 5, 3: 196 (1913). Type: Cape Province, Clanwilliam, Zwartboschkraal, *Schlechter* 5167 (B, holo. †; BOL!; Z!).

Disa atrorubens Schltr. in Bot. Jb. 24: 427 (1898); Schltr. in Bot. Jb. 31: 205 (1901).

Monadenia ophrydea Lindl. sensu Kraenzl., Orch. Gen. Sp. 1: 817 (1900), pro parte.

Plants 100–400 mm tall, suffused with beetroot-red; tubers 15–20 mm long, acute; basal sheaths hyaline, acute or obtuse, about 20 mm long, occasionally much longer; cauline leaves green, narrowly lanceolate to lanceolate, acute, the longest at the base, up to 90 mm long, semi-erect and sheathing at the base, upper leaves grading into the floral bracts, imbricate to subimbricate, acute; inflorescence slender, lax, (40–) 80–150 (–250) mm long and with (3–) 10–180 (–250) flowers; bracts green, lanceolate to narrowly ovate, acute, reaching the flowers or overtopping them; ovary slender, 15–20 mm long. *Flowers* horizontal, sepals and spur beetroot-red, lip and petals almost black; dorsal sepal narrowly oblong, obtuse, shallowly concave, 7–10 mm long, 3–4 mm wide and c. 1.5 mm deep; spur pendent from the base of the sepal, cylindrical, tapering to an acute apex, parallel to the ovary, 15–30 mm long; lateral sepals reflexed at anthesis, narrowly oblong, obtuse, 6–8 mm long; petals erect inside the galea, obliquely ovate, subacute, often shallow bidentate, fleshy apically and along the margins with papillae on the inside margin surface, 5–7 mm long and 3–5 mm wide; lip oblong to narrowly oblong, rounded, fleshy, horizontal basally but soon decurved, 5–7 (–8) mm long and 2–4 mm wide; rostellum erect, c. 1.5 mm tall with short lateral lobes flanking the caudices; anther semipendent, 1–1.5 mm long, the single viscidium a large disc; stigma c. 2 mm in diameter, on a pedicel as tall as the rostellum and angled forwards. Fig. 18

Diagnostic features. Plants suffused with beetroot-red in fresh state, reddish brown when dry, spur slender, up to 30 mm long, lip oblong to narrowly oblong, lateral sepals purple to beetroot-red, reflexed.

Flowering time: August–October.

The plants, suffused with beetroot-red, form small populations in sandy areas, where they may be seen in flower the first year after a fire. (Fig. 19).

CAPE.—3119 (Calvinia): between Oorlogs Kloof and Papkuilsfontein. (—AC), Sept. 1939, *Leipoldt* 3236 (BOL). 3318 (Cape Town): Pella Mission, common on sandflats after fire (—DA), Sept. 1977, *Linder* 1140 (BOL).

This species appears to be restricted to sandy areas in the western Cape Province between Houw Hoek and Calvinia, from near sea level to about 1 000 m in the northern end of the distribution area. Two populations were studied in the field (*Linder* 1140 & 1129). Both flowered the first year after the fire, and occurred on slightly seasonally damp deep sand. The populations were clearly defined, and within the area the species occurred frequently. Among the burnt twigs and branches the purplish red plants were scarcely visible. Despite extensive field work in the western Cape, no plants were found in unburnt vegetation.

Over the whole distribution range the summers are dry, and in the winter 500–800 mm rain falls.

The differences between this species and *M. ophrydea* are discussed above.

12. *Monadenia ophrydea* Lindl., Gen. Sp. Orch. 358 (1838); Kraenzl. Orch. Gen. Sp. 1: 817 (1900); Rolfe in Fl. Cap. 5, 3: 195 (1913). Type: Cape Province, Paarl, Drakenstein Mountains, *Drège* 8290 (K, holo.!).

Disa ophrydea (Lindl.) H. Bol. in Trans. S. Afr. phil. Soc. 5: 142 (1888); Schltr. in Bot. Jb. 31: 204 (1901).

Brownleea pantheriana Kraenzl. ex Zahlbr. in Ann. Nat. Hofmus. Wien 20: 6 (1905). Type: Cape Province, Montagu Pass, *Panther* 189 (W, holo.!).

Plants slender, up to 400 mm tall, suffused with beetroot-red tubers 10–20 mm long; basal sheaths 1–2, hyaline, obtuse or acute, 1 (–3) mm long; leaves green, narrowly lanceolate, acute, rarely obtuse, the largest near the base of the stem, up to 100 mm long and 20 mm wide, usually imbricate; inflorescence lax, up to 300 mm long with (1–) 5–15 (–30) flowers; bracts purplish-green, ovate to shortly acuminate, 20–40 mm long and 15–25 mm wide, generally as tall as the flowers; ovaries 20–25 mm long. *Flowers* horizontal, purple-red, the lateral sepals paler and often white; dorsal sepal oblong-obovate, shallowly galeate, rounded, 9–11 mm long, 5–7 mm wide and 1–2 mm deep; spur pendent from the base of the dorsal sepal, slender, tapering to an acute apex, slightly curved towards the ovary, 20–24 mm long; lateral sepals spreading, narrowly ovate, acute, rarely somewhat reflexed, much paler than the rest of the flower, 8–10 mm long; petals erect inside the galea, very obliquely ovate, acute with a shallowly emarginate apex, falcate in side view, somewhat curved around the rear of the anther, the apex and anterior margins fleshy; lip narrowly elliptical to almost lorate, subacute to acute, fleshy, pendent, 8–10 mm long; rostellum simple, flanking the caudicles, c. 3 mm tall; anther semipendent, c. 4 mm long, pollen-masses almost globular, viscidium almost globular, 0.8 mm in diameter; stigma equally tripulvinate, c. 1, 5 mm in diameter, about $\frac{1}{2}$ as tall as the rostellum. Fig. 18.

Diagnostic features. Plant suffused with a beetroot-red when fresh, reddish brown when dry, spur slender, up to 24 mm long, lateral sepals reddish and white, spreading, lip narrowly elliptical to lorate.

Flowering time: October and November.

A slender herb, suffused with beetroot-red, occurring usually in extensive populations in recently burnt veld on mountain sides, in damp conditions, in the western and southern Cape Province (Fig. 19).

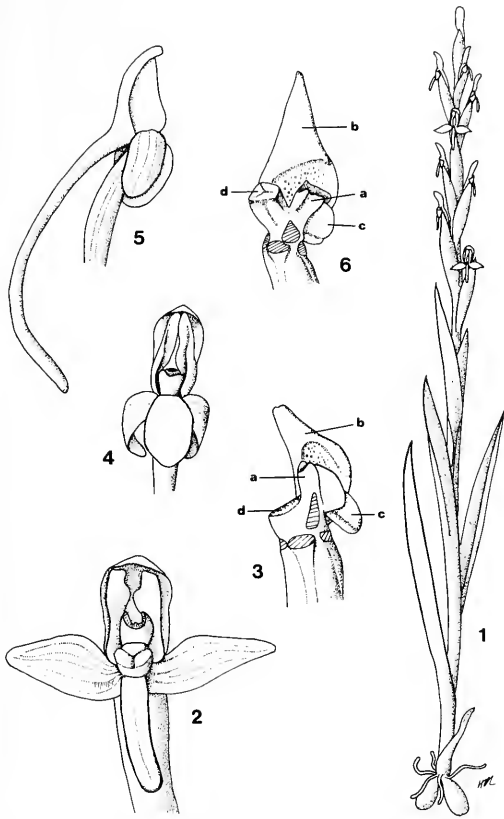


FIG. 18.—*Monadenia ophrydea* (1–3) and *M. atrorubens* (4–6). 1, plant of *M. ophrydea*, from Esterhuysen 10573, $\times 0.5$. 2, front view of flower, $\times 3$. 3, dissection of flower, $\times 5$. (2–3 from Linder 1596.) 4, front view of flower of *M. atrorubens*, $\times 3$. 5, side view of flower, $\times 3$. 6, dissection of flower, $\times 5$: a, rostellum; b, petal; c, anther; d, stigma. (4–6 from Linder 1129.)

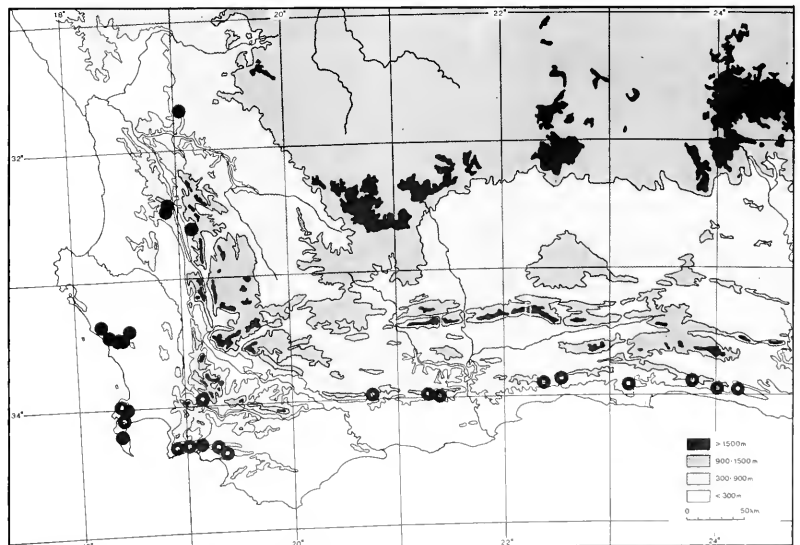


FIG. 19.—Distribution of *Monadenia atrorubens* (solid circles) and *Monadenia ophrydea* (open circles).

CAPE.—3318 (Cape Town): damp grassland on Table Mountain, 700 m (—CD), Oct. 1879, *Bolus 4538* (BOL). 3323 (Willowmore): Outeniqua Mountains near Joubertina (—DD), Dec. 1946, *Esterhuysen in BOL 23635* (BOL).

Several populations of this distinct species have been studied over the length of the distribution range. Generally the populations are extensive with numerous individuals, occurring on damp peaty mountain slopes facing the coast and consequently the rain-bearing winds. This species, as in *M. atrorubens*, appears to flower only after fire, when the beetroot-red plant colour is cryptic in the burnt-out vegetation. The altitude range is from near sea level in the Betty's Bay (Caledon) area to more commonly 300–1 000 m in the Langeberg and eastwards to Humansdorp. Over the whole distribution range, the species receives some precipitation throughout the year: in the east from the all-the-year rains and in the west from condensation or occasionally rain from the 'south-easter' clouds.

For the differences from *M. atrorubens*, see above.

13. *Monadenia rufescens* (Thunb.) Lindl., Gen. Sp. Orch. 356 (1838); Kraenzl., Orch. Gen. Sp. 1: 818 (1900). Type: Cape of Good Hope, *Thunberg* in herb. Thunberg 21456 (UPS; holo.!; W!).

Satyrium rufescens Thunb., Prod. 5 (1794). *Disa rufescens* (Thunb.) Swartz in Vet. Acad. Handl. 21: 210 (1800); Schltr. in Bot. Jb. 31: 209 (1901). *Monadenia lancifolia* Sond. in Linnaea 19: 100 (1847), nom. nov.

Monadenia macrocarpa Lindl., Gen. Sp. Orch. 358 (1838); Rolfe in Fl. Cap. 5, 3: 193 (1913). Type: Cape of Good Hope, *Thom s.n.* (K, holo.!).

Monadenia leptostachya Sond. in Linnaea 19: 101 (1847). Type: Cape Province, Cape Peninsula near Wynberg, *Ecklon & Zeyher s.n.* (S, holo.!; P!; W!).

Icon: H. Bol., Icones Orch. Austro-Afr. 2: t. 89 (1911).

Plants erect, 140–235–400 mm tall; tubers testicular, 20 mm in diameter; base of the stem often with the remnants of old leaf fibres; basal sheaths hyaline, grading into the leaves; leaves imbricate, the largest leaves near the base of the stem, narrowly lanceolate, to linear, acute, 50–70 mm long, conduplicate, gradually smaller and more sheathing towards the apex of the stem, grading into the floral bracts; inflorescence a slender spike, 30–150 mm long and 15 mm in diameter, with 2–25 flowers; ovaries 10–15 mm long; bracts usually slightly longer than the ovaries, narrowly ovate, acuminate, dark green, imbricate and partially obscuring the flowers. *Flowers* lime-green with dark purple petals and lip; dorsal sepal angled forwards, shallowly galeate, oblong, obtuse to rounded, 9–11 mm long and c. 1 mm deep; spur pendent from the base of the galea, slender cylindrical, acute, 10–16 mm long; lateral sepals erect or patent, oblong, obtuse, 6–8 mm long; petals obliquely narrowly oblong, obliquely truncate, wider at the base, subfleshy, concave, 6–7 mm long, the broad basal part enclosing the anther, the narrowly oblong apical part forming a tube with the dorsal sepal; lip decurved, narrowly oblong, obtuse, 6–7 mm long; anther semipendent, 1.5 mm long, viscidium elongated backwards with a longitudinal dorsal groove; rostellum c. 1 mm tall; stigma pedicellate, not as tall as the rostellum. Fig. 20.

Diagnostic features. Flowers with the lateral sepals 6–8 mm long, spur slender acute, 10–16 mm long; floral bracts prominent, green; leaves gradually grading from large at the base to sheathing at the apex; stigma lower than the rostellum.

Flowering time: (September–) October (–November).

Monadenia rufescens is a slender herb that occurs occasionally in seasonally damp localities in the western Cape Province, between sea level and 1 000 m (Fig. 21).

CAPE.—3318 (Cape Town): Lower Plateau of Table Mountain, 750 mm (—CD), Oct. 1884, *Bolus 4969* (BOL). 3418 (Simonstown): Vlakkenberg vlei, 600 m (—AB), Oct. 1947, *Compton 20180* (NBG). 3419 (Caledon): flats east of Viljoenspass (—AA), Sept. 1949, *Stokoe in SAM 61250* (SAM).

The nomenclatural history of this species is complex. The type of *Satyrium rufescens*, although not in a good condition, is clearly recognizable. However, Lindley (1838) misidentified *Satyrium rufescens* Thunb. ('I know no plant to which the definitions of Swartz and Thunberg exactly apply'). His description of *Monadenia rufescens* (Thunb.) Lindl. applies to *Drège 1252*, and must be referred to *M. comosa* Reichb. f. However, the combination *Monadenia rufescens* (Thunb.) Lindl. is valid, and has to be used for *M. rufescens* sensu Thunb. Ironically, the other

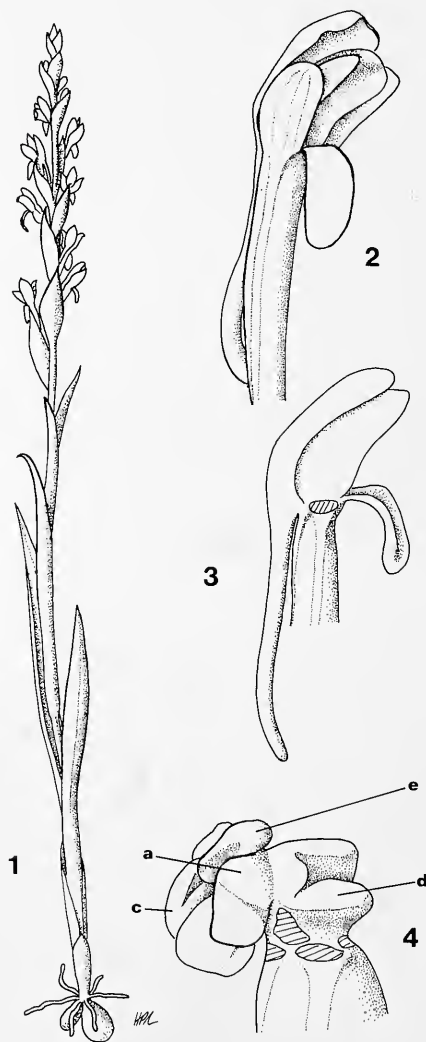
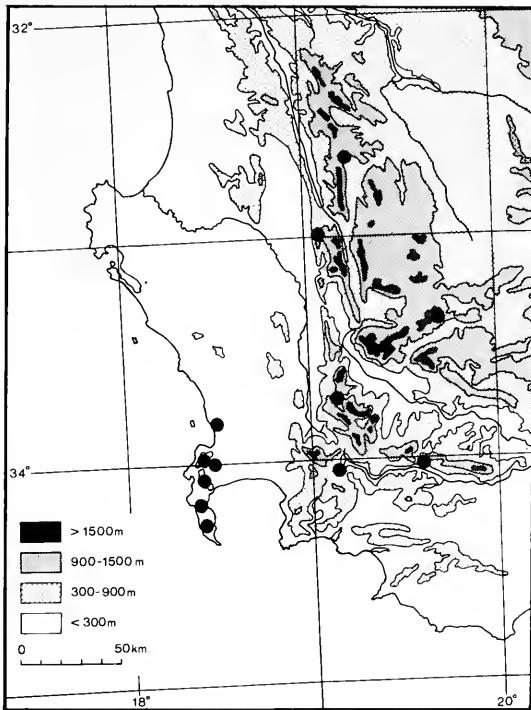


FIG. 20.—*Monadenia rufescens*. 1, whole plant, from Salter 8479, $\times 0.5$; 2, flower in angled front view, $\times 3$; 3, flower in side view with the lateral sepal removed, $\times 3$; 4, column, $\times 10$; a, rostellum; b, anther; c, stigma; d, viscidium. (2–4 from Linder 1610.)

FIG. 21.—Distribution of *Monadenia rufescens*.

collection cited by Lindley is clearly *Satyrion rufescens* Thunb. Sonder (1847) noted that *Monadenia rufescens* Lindl. is not the same as *Disa rufescens* (Thunb.) Swartz. He upheld the former, and proposed *Monadenia lancifolia* as a *nomen novum* for the latter. Lindley (1838) had also received a specimen of the true *Satyrion rufescens* Thunb., and named it *Monadenia macrocera* (1838). This name was used by Rolfe (1913), who followed the 'Kew Rule'. Sonder (1847) also proposed another name, *Monadenia leptostachya* for the species which he separated from *M. lancifolia* on several characters. Examination of the types indicated that these names all apply to the same taxon.

Monadenia rufescens is systematically relatively isolated within the group of slender long-spurred species of *Monadenia*. The dorsal sepal and petals are angled forwards and are applied to each other to form a tube leading over the rostellum into the spur. The rostellum is higher than the stigma and the single large viscidium is elongated backwards. Consequently it has a large surface exposed to the proboscis of an insect probing into the spur. The viscidium also has a longitudinal dorsal groove, which may also be related to this pollination syndrome. Further the species may be distinguished by the leathery bracts and the purple petals and lip.

Although *M. rufescens* is relatively widespread in the western Cape Province, it does not appear to be common at any locality and plants frequently appear to occur singly. The majority of collections are from slightly damp localities in a variety of habitats, ranging from dunes to rocky mountain sides at about 1 000 m. Although the distribution range covers an area of summer drought, many of the sampled localities must receive at least some moisture condensed from the 'south-easter' clouds.

This species is not well known, and more field data could cast some light on its ecological requirements.

Sect. *Monadenia*

Spur longer or shorter than the dorsal sepal, clavate; flowers relatively large, sepals 7–14 mm long; inflorescence generally dense.

Type species: *Monadenia brevicornis* Lindl.

This section of three species is clearly defined by the swollen or clavate spurs, the larger flowers and the more robust plants. Only *M. brevicornis* approaches *M. reticulata* in some populations.

The three species replace each other geographically, with narrow overlap zones. *M. physodes* occurs between the Kamiesberg in Namaqualand and the Cape Peninsula. *M. cernua* extends from the Cape Peninsula to Humansdorp, whereas *M. brevicornis* is widespread in montane grasslands in southern Africa, reaching as far south-west as Knysna. Although the vast majority of the collections are readily distinguished on morphological features, there are some intermediate collections between *M. physodes* and *M. cernua* and between *M. brevicornis* and *M. reticulata*.

M. physodes and *M. cernua* are readily distinguished by the relative spur length (Fig. 22). However, some of the collections from the overlap zone on the Cape Peninsula are rather difficult to assign to one of the two species, whereas others do not present any difficulty (i.e. *Le Sueur* in *BOL* 4973). One of the intermediate collections is the type collection of *M. inflata* Sond. An analysis of several flowers from this collections indicated that it is best placed under *M. cernua*.

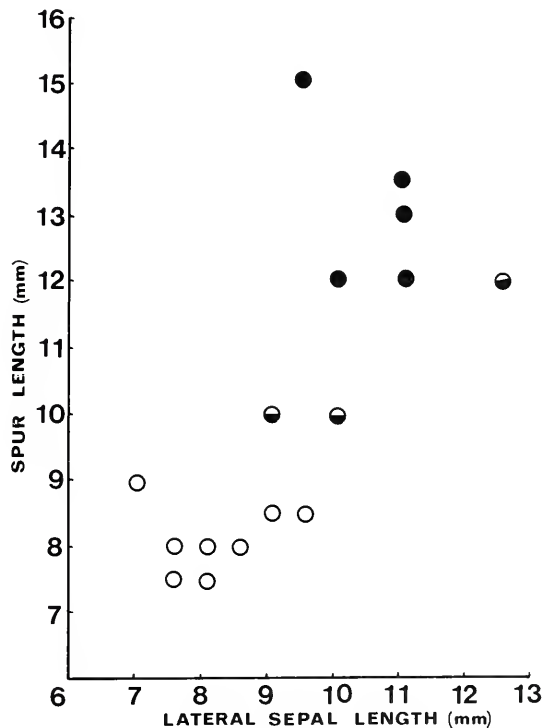


FIG. 22.—Variation in the relative spur length in *Monadenia physodes* and *M. cernua*. The solid circles represent *M. cernua* and the open circles *M. physodes*. The half-solid circles represent two collections from the Cape Peninsula that are intermediate between the two taxa, one of which is the type collection of *Monadenia inflata*.

There are no intermediate forms in the overlap zone between *M. cernua* and *M. brevicornis* — as though the morphological differences between the two taxa are accentuated in this area, with collections of *M. cernua* with longer spurs than is usually found in this species.

However, the southernmost populations of *M. brevicornis* approach *M. reticulata*. Generally these two taxa are separated by the wider and more robust cauline leaves and more inflated spurs of *M. brevicornis*. In collections from the Uniondale area (*Esterhuysen* 10692) the leaves are narrower, more clustered towards the base of the stem, and the spurs are more slender. A possible explanation is hybridization between these two taxa, with introgression into *M. brevicornis*.

14. *Monadenia physodes* (Swartz) Reichb. f. in *Flora* 66: 461 (1883); Rolfe in *Fl. Cap.* 5, 3: 191 (1913). Type: Cape of Good Hope, *Thunberg* in herb *Thunberg* 21455 (UPS, holo.!).

Disa physodes Swartz in *Vet. Acad. Handl.* 21: 211 (1800); *Thunb.*, *Fl. Cap.* 12 (1823); *Lindl.*, *Gen. Sp. Orch.* 356 (1838); *Kraenzl.*, *Orch. Gen. Sp.* 1: 788 (1900).

D. cernua (Thunb.) Swartz, *Schltr. in Bot. Jb.* 31: 210 (1901), pro parte.

Plants robust, 250–600 mm tall; tubers up to 40 mm long; basal sheaths hyaline, obtuse, 1–2; leaves linear-lanceolate, acute, conduplicate, falcately erect, the longest at the base, 140–200 mm long and c. 20 mm wide, grading apically into the foral bracts; inflorescence cylindrical, 50–300 mm long and 30–40 mm in diameter, flowers subimbricate; ovaries c. 15 mm long; bracts as long as the flowers, narrowly ovate, acuminate. *Flowers* with lime-green sepals, often mottled or suffused maroon, petals lime-green; dorsal sepal shallowly galeate, oblong, obtuse erect, 9–11 mm tall and c. 1 mm deep; spur pendent from the base of the galea, clavate, rounded, 7–9 mm long and 3–6 mm wide, adpressed to the ovary; lateral sepals reflexed, oblong, obtuse to rarely acute, 7–10 mm long; petals obliquely narrowly ovate-oblong, bluntly acuminate or obliquely retuse, 7–9 mm long, the broad basal part enclosing the anther and the narrower apical part twisted to face out of the galea; lip pendent, lorate to narrowly oblanceolate, rounded,

7–10 mm long; anther semipendent, 2 mm long; rostellum lateral lobes large, flanking the anther, 2 mm tall, stigma on a 1 mm tall pedicel, horizontal, lateral lobes much larger than the central lobe.

Diagnostic features. Flowers with the lateral sepals 7–10 mm long; spur clavate, rounded, 7–9 mm long, rostellum up to 2 mm tall.

Flowering time: September–October.

This robust herb occurs in the western Cape Province, mostly in swampy localities, but at least one record is from a dry slope after a fire (Fig. 23).

CAPE.—3018 (Kamiesberg): Leliefontein, Little Namaqualand (–AB), Oct. 1940, *Leipoldt* 3809 (BOL). 3318 (Cape Town): about 6 km north of Malmesbury (–BC), Oct. 1964, *Rabinowitz* in *NBG* 77143 (NBG); lower slopes of Lions Head near Sea Point, 80 m (–CD), Sept. 1884, *Le Sueur* in *BOL* 4973 (BOL).

Thunberg (1794) regarded this species as synonymous with *M. cernua*, as he cites both in his protologue. *M. physodes* was only separated by Swartz in 1800. In general, the distinction between the two taxa has been recognized, except for *Schlechter* (1901), who regarded *M. physodes* merely as a smaller form of *M. cernua*.

This species is unique because of its strongly clavate spur which is shorter than the dorsal sepal. It is clearly allied to *M. cernua*, but may readily be distinguished by the relatively short spur and the peculiar rostellum with massive lateral lobes flanking the anther.

I have not seen any populations of this peculiar species in the wild, and collectors notes do not indicate the habitat. *Oliver* (*Oliver* 4761) reports that near Ceres the species flowered in sandy stony flats after a fire.

The altitude range of the species is from near sea level at Sea Point, to over 1 000 m in some inland localities. Many of the localities of herbarium collections are now disturbed, and the number of populations of the species must be much reduced from that of a century ago. The distribution range of the species falls in an area of summer drought and total rainfall values of 500–800 mm p.a.

There are two records of an unpleasant mouse-like scent.

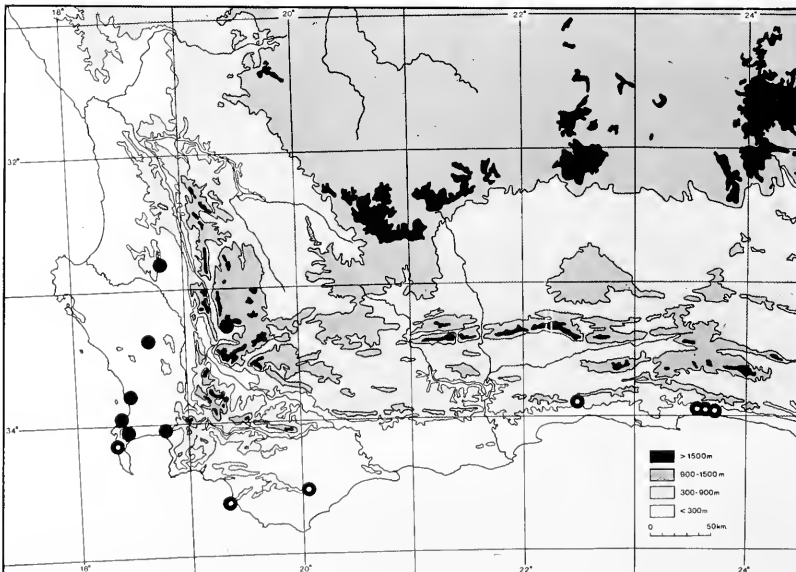


FIG. 23.—Distribution of *Monadenia physodes* (solid circles) *Monadenia cernua* (open circles).

15. *Monadenia cernua* (Thunb.) Dur & Schinz, Consp. Fl. Afr. 5: 111 (1894); Kraenzl., Orch. Gen. Sp. 1: 815 (1900); Rolfe in Fl. Cap. 5, 3: 192 (1913). Type: Cape of Good Hope, *Thunberg* in herb. Thunberg 21431, 21432 (lecto.), 21433 (all UPS!).

Satyrium cernuum Thunb., Prodr. Pl. Cap. 5 (1794). *Disa cernua* (Thunb.) Swartz in Vet. Acad. Handl. 21: 211 (1800); Thunb., Fl. Cap. 12 (1823); Lindl., Gen. Sp. Orch. 356 (1838); Schltr. in Bot. Jb. 31: 210 (1901), excl. *M. physodes*.

Disa prasinata Ker-Gawl. in Edwards's bot. Reg. t. 210 (1817). *Monadenia prasinata* (Ker-Gawl.) Lindl., Gen. Sp. Orch. 358 (1838). Type: Edwards's bot. Reg. t. 210 (1817), iconotype.

Monadenia inflata Sond. in Linnaea 19: 102 (1847). Type: Cape Province, Cape Peninsula near Wynberg, *Ecklon & Zeyher* s.n. (S, holo.; BOL; K!; P!; SAM!; W!; Z!).

Icones: Edwards's bot. Reg. t. 210 (1817); H. Bol., Icones Orch. Austro-Afr. 2: t. 91 (1911), as *Disa cernua*.

Plants robust, 200–600 mm tall; basal sheaths hyaline, obtuse, 1–2; leaves linear-lanceolate, acute, conduplicate, imbricate, the largest at the base, (100–) 140–200 mm long and 15–20 mm wide, grading apically into the floral bracts; inflorescence 100–250 mm long and 30–40 mm in diameter, flowers subimbricate; ovaries c. 15 mm long; bracts as tall as the flowers, narrowly ovate, subacuminate. Flowers with cream-green sepals, mottled maroon, and lime-green petals and lip; dorsal sepal shallowly galeate, slightly angled forwards, oblong, obtuse, 10–14 mm long and c. 1 mm deep; spur pendent from the base of the galea, clavate, rounded, 11–17 mm long and 3–5 mm wide, adpressed to the ovary; lateral sepals reflexed, narrowly oblong to oblong, acute to obtuse, 9–13 mm long; petals subobliquely narrowly ovate-oblong, bluntly acuminate to obliquely retuse, 7–10 mm long, the broad basal part flanking the anther and the narrow apical part twisted to face out of the galea; lip pendent lorate, rounded, subfleshy, 8–12 mm long; anther subhorizontal, 3 mm long; rostellum with 2–3 mm tall lateral lobes flanking the anterior part of the anther; stigma on a 1 mm tall pedicel, slightly angled forwards, flat, lateral lobes larger than the posterior lobe. Fig. 24.

Diagnostic features. Flowers with the lateral sepals 9–13 mm long; spur clavate, rounded, 11–17 mm long; rostellum with 2–3 mm tall side lobes.

Flowering time: (September–) October (–November).

Monadenia cernua is a tall robust herb that occurs in damp to swampy habitats in the western and southern Cape Province, (Fig. 23) on the flats between the mountains and the sea, from the Cape Peninsula to Humansdorp.

CAPE.—3318 (Cape Town): Rietvalley (–DC), Oct. *Zeyher* 1569 (SAM). 3322 (Oudtshoorn): Montagu Pass, George, 400 m (–CD), Oct. 1880, *Young* in BOL 5534 (BOL). 3323 (Willowmore): between Keurboms River and Storms River (–CD), Oct. 1938, *Gülden* 4565 (BOL).

Satyrium cernuum Thunb. was based on a mixed type; The discordant element was removed by Swartz and described as *Disa physodes* (1800).

In 1817 Ker-Gawler described *Disa prasinata* from a plant imported from South Africa by a Mr Griffin, who successfully flowered it. The plate in Edwards's Botanical Register has to serve as an iconotype, as no other type material is available. From the illustration it is difficult to decide whether the plant belongs to *M. physodes* or *M. cernua*, but the spur appears to be slightly longer than the dorsal sepal, a character also found in a *Ecklon & Zeyher* collection from Rietvlei

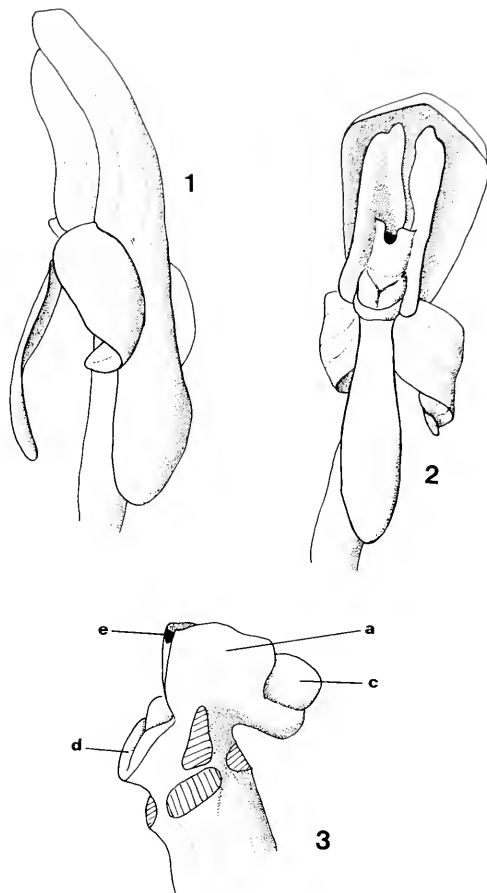


FIG. 24.—*Monadenia cernua*. 1, flower in side view, $\times 3$. 2, flower in front view, $\times 3$. 3, column in side view, $\times 6$: a rostellum; c, anther; d, stigma; e, viscidium. All from *Walters* 536.

near Cape Town. This collection is grouped with *M. cernua*. *Disa prasinata* is therefore regarded as a synonym of *M. cernua*. The type of *Monadenia inflata* Sond. agrees in all characters with *M. cernua*.

This species is closely related to both *M. brevicornis* and *M. physodes*, and to some extent present a morphocline between these two taxa. It may be distinguished from the former by the rounded to obtuse spur, which is straight and not curved towards the ovary, and from the latter by the spur which is longer than the lateral sepal (Fig. 22).

The single population of this species which I studied in the field occurred on the Tsitsikamma coast, in a marshy area along the National Road. In this part of the country there are very few natural habitats still extant. Collectors' notes from the Bredasdorp area indicate that *M. cernua* occurs in damp sandy habitats. No further habitat data are available. One collection from Tsitsikamma (*Bower* 600) was found after fire.

The altitude range of the species is from near sea level at Cape Town, to more commonly between 100 and 300 m above sea level on the coastal flats. The majority of the populations must have been destroyed, as most of the area is under fairly intense cultivation, and in the Knysna area, afforested. Over the whole distribution range at least some summer rainfall occurs. The total rainfall varies from about 600 mm to over 1 000 mm p.a.

16. *Monadenia brevicornis* Lindl., Gen. Sp. Orch. 357 (1838); Kraenzl., Orch. Gen. Sp. 1: 816 (1900); Rolfe in Fl. Cap 5, 3: 192 (1913). Type: Cape of Good Hope, *Mund* s.n. (K, holo.).

Disa brevicornis (Lindl.) H. Bol. in J. Linn. Soc., Bot. 25: 196 (1889); Schltr. in Bot. Jb. 31: 211 (1901).

Icon: H. Bol., Icones Orch. Austro-Afr. 3: t. 40b (1911).

Plants 200–500 mm tall; tubers up to 50 mm long; leaves narrowly lanceolate to rarely narrowly ovate, acute, numerous, imbricate, the largest near the base, up to 150 mm long and grading apically into the floral bracts; inflorescence a lax or cylindrical spike, 40–300 mm tall; ovaries 10–15 mm long, more or less erect; bracts as tall as or overtopping the flowers, narrowly ovate to ovate, acuminate. *Flowers* with lime-green petals and lip, lip with a maroon base, lateral sepals green, dorsal sepal rust-coloured to maroon; dorsal sepal erect, shallowly galeate, obtuse to rounded, apiculate, narrowly obovate to oblong, 7–10 mm tall and c. 1 mm deep; spur pendent with the apex curved towards the ovary, cylindrical, 2–3 mm in diameter and 7–11 mm long; lateral sepals reflexed, oblong, obtuse, apiculate, 5–9 mm long; petals obliquely narrowly ovate to oblong, obliquely retuse, erect and twisted to face forwards, 5–9 mm tall; lip pendent, narrowly oblong, obtuse, 6–8 mm long; anther semipendent, 1.5–2 mm long; rostellum partially flanking the anther with a deep notch to the front containing the viscidium, 1–2 mm tall; stigma with the rear lobe smaller than the lateral lobes shortly pedicellate, horizontal. Fig. 25.

Diagnostic features. Flowers large, lateral sepals 5–9 mm long; spur cylindrical, acute, the apex curved towards the ovary, 7–11 mm long and 2–3 mm in diameter.

Flowering time: November–February.

Monadenia brevicornis is a slender herbaceous orchid, that occurs frequently in montane grassland from the southern Cape Province to southern Malawi and Madagascar (Fig. 26).

CAPE.—3423 (Kynsna): The Crag, Knysna (—AA), Nov. 1949, *Compton* 21729 (NBG).

TRANSKEI.—3129 (Port St Johns): Port St Johns (—DA), Oct. 1939, *McLoughlin* 403 (BOL).

NATAL.—2930 (Pietermaritzburg): escarpment above the Byrne valley (—CC), Nov. 1975, *Hilliard* 5583 (NU).

ZIMBABWE.—Inyanga, Bidford Estate, 1 800 m, March 1958, *Beasley* 64 (K; SRGH).

This species is closely allied to *M. cernua*, from which it may be distinguished by the acute spur. From the rest of the genus, the species is distinct, because of its inflated spur, longer than the dorsal sepal, and its distribution in the summer rainfall/winter drought region.

M. brevicornis occurs very widespread in the montane grassland regions of southern Africa. Generally plants are found in slightly damp areas in the grassland. The altitudinal range varies from near the coast in the southern Cape Province (where some populations occur in Cape 'Fynbos' in the Humansdorp, Grahamstown and King William's Town areas), to between 1 300 and 2 700 m in Natal and northwards to Malawi. In this region the rainfall of about 800–1 200 mm p.a. occurs almost totally in the summer months, whereas the higher altitudes receive snow in the winter months (White, 1978). Populations tend to be extensive and sparse.

Although the species appears to be relatively common in South Africa and Zimbabwe, there is only a single collection known from Malawi (Mt Mlanje) and from Madagascar.

As at least Mt Mlanje in Malawi has been floristically well investigated by various botanists, the species has to be accepted as being rare in that country.

A sweet scent has occasionally been recorded.

PUTATIVE HYBRIDS

Monadenia atrorubens × *sabulosa*

Linder 1510 consists of a single plant found at Betty's Bay in the western Cape, growing between populations of both putative parents. The specimen is intermediate for all characters between the two parents.

EXCLUDED SPECIES

Monadenia leydenburgensis Kraenzl., Orch. Gen. Sp. 1: 811 (1900); Rolfe in Fl. Cap. 5, 3: 189 (1913). Type: Transvaal, Lydenburg, along the Crocodile

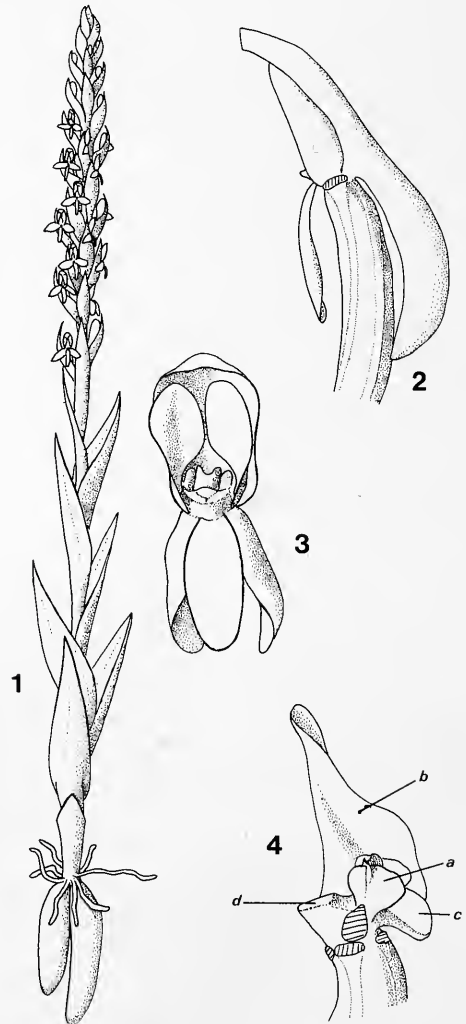
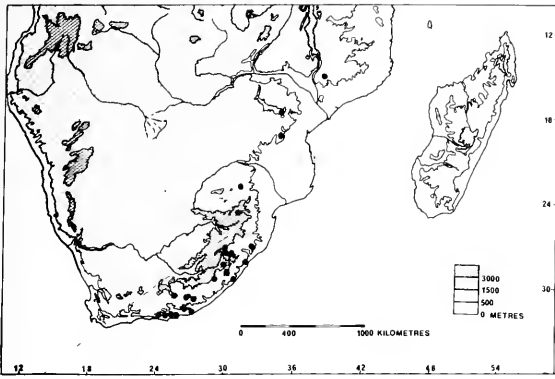


FIG. 25.—*Monadenia brevicornis*. 1, whole plant, $\times 0.5$. 2, flower in side view with one sepal removed, $\times 3$. 3, flower in front view, $\times 3$. 4, dissection of flower, $\times 6$: a, rostellum; b, petal; c, anther; d, stigma. All from *McLoughlin* 42.

FIG. 26.—Distribution of *Monadenia brevicornis*.

River, Wilms 1864 (Z, holo.; BM!; K!) = *Disa stachyoides* Reichb. f. in Flora 64: 328 (1881).

Monadenia basutorum (Schltr.) Rolfe in Fl. Cap 5, 3: 196 (1913), based on *Disa basutorum* Schltr. in Bot. Jb. 20, 50: 17 (1895). Type: Natal, Drakensberg summit, Thode s.n. (K, iso!) = *Disa basutorum* Schltr.

Monadenia junodiana Kraenzl. in Vierteljahrschr. Nat. Ges. Zürich 74: 108 (1929). Type: Transvaal, Mamotsuri, Junod 1208 (Z, holo.!) = *Disa fragrans* Schltr. in Bot. Jb. 20, 50: 40 (1895).

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UITTREKSEL

Die genus *Monadenia* (Disinae, Orchidaceae) word hersien. Sestien spesies, in vier seksies verdeel, word erken. Die verspreiding van elke spesie word afgebaan en twee spesies word geïllustreer. 'n Hipotese oor die filogenetiese verwantskappe van die spesies word aangebied.

REFERENCES

- BENTHAM, G. & HOOKER, J. D., 1883. *Genera Plantarum* III. London.
- BOLUS, H., 1888. The orchids of the Cape Peninsula. *Trans. S. Afr. phil. Soc.* 5: 1–201.
- BOLUS, H., 1889. Contributions to South African botany, part IV. *J. Linn. Soc., Bot.* 25: 156–209.
- BOLUS, H., 1893. *Icones Orchidearum Austro-Africanarum* 1, part 1. London: Wesley.
- BOLUS, H., 1896. *Icones Orchidearum Austro-Africanarum* 1, part 2. London: Wesley.
- BOLUS, H., 1911. *Icones Orchidearum Austro-Africanarum* II. London: Wesley.
- BOLUS, H., 1913. *Icones Orchidearum Austro-Africanarum* III. London: Wesley.
- BURDET, H.M., 1978. Cartulae ad botanicorum graphicem XIII. *Candollea* 33: 365–405.
- BROWN, N. E., 1815. Terrestrial orchids of South Africa. *Gdnrs' Chron.* 24: 402–404.
- BROWN, N. E., 1818. *Disa bracteata*. *Edwards's bot. Reg.* 4: t. 324.
- DURAND, T. & SCHINZ, H., 1894. *Conspectus Florae Africae* V. Bruxelles: Charles van de Weghe.
- DYER, R. A., 1976. *The genera of southern African flowering plants*. II. *Gymnosperms and monocotyledons*. Pretoria: Botanical Research Institute.

- ERIKSON, R., 1965. *Orchids of the West*.
- GOEDBLATT, P., 1978. An analysis of the flora of southern Africa: its characteristics, relationships, and origins. *Ann. Mo. bot. Gdn* 65: 369–436.
- HOLMGREN, P. K. & KEUEN, W., 1974. *Index Herbariorum, part 1. The herbaria of the world*. Utrecht: Oosthoek, Scheltema & Holkema.
- KER, J. B., 1817. Of the three species of the natural order Orchideae. *Q. Jl Sci. Arts* 4: 199–206.
- KRAENZLIN, F., 1900. *Orchidacearum Genera et Species*. Vol. 1, part 13. Berlin: Mayer & Mueller.
- LEWIS, G. J., 1948. *Plantae novae africanae*. *Jl S. Afr. Bot.* 14: 31.
- LEWIS, G. J., 1950. Orchidaceae. In Adamson, R. S. & Salter, T. M. (eds) *Flora of the Cape Peninsula*. Cape Town: Juta.
- LINDER, H. P., 1981a. Taxonomic studies in the Disinae. IV. A revision of *Disa* Berg. sect. *Micranthae* Lindl. In preparation.
- LINDER, H. P., 1981b. Taxonomic studies in the Disinae. VI. A revision of *Herschelia* Lindl. *Bothalia* 13: 000–000.
- LINDLEY, J., 1838. *The genera and species of orchidaceous plants*. London: Ridgways.
- PRITZER, E., 1889. Orchidaceae. In Engler, A. & Prantl, K. (eds) *Die natürlichen Pflanzenfamilien* 2.6 Leipzig: Engelmann.
- PHILLIPS, E. P., 1926. The genera of South African flowering plants. *Mein. bot. Surv. S. Afr.* 10.
- POCOCK, M. R., 1972. *Ground orchids of Australia*.
- REICHENBACH, H. G., 1847. Orchidographische Beiträge. *Linnaea* 20: 673–696.
- REICHENBACH, H. G., 1883. Die Orchideen des Herbars Thunbergs. *Flora* 66: 459–463.
- ROLFE, R. A., 1913. Orchidaceae. In Thiselton-Dyer, W. T. (ed.) *Flora Capensis* 5, 3. London: Reeve.
- ROURKE, J. P., 1972. Taxonomic studies on *Leucospermum* R. Br. *Jl S. Afr. Bot. Suppl.* Vol. 8.
- RUPP, H. M. R., 1946. Two new orchids from western Australia. *Australian Orchid Review* 11: 70.
- SCHELPE, E. A., 1966. *An introduction to the South African orchids*. Cape Town: Punell.
- SCHLECHTER, R., 1898. Orchidaceae africanae novae vel minus cognitae. *Bot. Jb.* 24: 418–433.
- SCHLECHTER, R., 1901. Monographie der Disaeae. *Bot. Jb.* 31: 134–313.
- SCHLECHTER, R., 1924. Contributions to South African Orchidology. *Ann. Transv. Mus.* 10: 233–252.
- SENGHAS, K., 1973. Orchidoideae. In R. Schlechter (ed.), *Die Orchideen*, ed. 3. Paul Parey.
- SONDER, G., 1847. Enumeratio Orchideatum, quas in Africa Australi Extra-tropicum collegerunt C. F. Ecklon, Dr. et C. Zeyher. *Linnaea* 19: 71–112.
- STAFLEU, F. A., et al., 1978. *International code of botanical nomenclature*. Utrecht: Bohn, Scheltema & Holkema.
- SWARTZ, O., 1800. Orchidemes slagter och arter uppstalade. *Kongliga Vetenskaps Academi Handlinger*, Stockholm 31: 202–254.
- TAYLOR, H. C., 1978. Capensis. In Werger, M. J. A. (ed.) *Biogeography and ecology of southern Africa*. The Hague: Junk.
- THUNBERG, C. P., 1794. *Prodromus Plantarum Capensium*. Upsala.
- THUNBERG, C. P., 1823. *Flora Capensis*. ed. J. A. Schultes. Stuttgart: Gardt.
- WHITE, F., 1978. The afro-montane Region. In Werger, M. J. A. (ed.) *Biogeography and ecology of southern Africa*. The Hague: Junk.

APPENDIX: SPECIMENS STUDIED

The specimens are listed alphabetically according to the name of the collector. The figures in brackets refer to the number of the taxon in the text. Herbaria from which each collection has been studied are indicated by the letter codes of Holmgren & Keuken (1974). Two taxon numbers connected by a dash, e.g. (3–4), indicates that the collection is a hybrid between the two species.

- Acocis* 1030 (5) S; 5318 (5) S; 19866 (5) PRE; 22797 (15) PRE; 23499 (5) PRE. *Adansonia* 438 (16) K; in SAM 52937 (12) SAM. *Alexander* s.n. (5) K. *Andraea* 27 (6) PRE; sub *Marloth* 645 (9) PRE. *Atherstone* 25 (16) K.
- Ball* 550 (16) K; 568 (16) K. *Barber* 445 (16) K. *Barker* 328 (14) NBG; 1622 (5) NBG; 3398 (13) NBG; 3892 (5) NBG; 3893 (6) NBG; 3925 (2) NBG; 4172 (5) NBG; 8838 (8) NBG. *Beasley* 64 (16) K. *Begley* 8 (10) SAM. *Boardman* 49 (16) BOL; 262 (16) PRE. *Bodkin* in BOL 4903 (10) BOL; 4970 (4) BOL, G. PRE, SAM, Z; 4988 (8) BOL, K; 6231 (2) BOL. *Bohnen* 1066 (5) PRE. *Bolus* 3859 (5) BM, BOL, K, Z; 4336 (14) K; 4538 (12) BM, BOL, K, Z; 4542 (8) BOL; 4551 (13) BM, BOL, K, PRE, Z; 4555 (9) BM, BOL, K, SAM, Z; 4885 (6) BOL, K, PRE, Z; 4897 (8) BOL, K; 4969 (13)

BOL., K. Z; 4973 (14) PRE; 6862 (6) Z; 7104 (3) BOL., SAM; 7317 (16) BOL., G. Z; 9938 (11) BOL.; 11646 (9) BOL.; 13504 (4) BOL.; 13505 (6) BOL.; *sub Guthrie* 1080 (3) BOL.; s.n. (5) BOL.; s.n. (5) BOL.; s.n. (8) BOL.; s.n. (9) BOL.; s.n. (11) BOL.; s.n. (13) BOL. *Bond* 115 (9) NBG; 1206 (9) NBG. *Boucher* 699 (5) STE; 829 (12) STE; 1642 (12) STE; 1946 (9) STE; 2422 (5) PRE, STE. *Bower* 600 (15) PRE. *Boyle* 25 (16) K. *Buchanan* s.n. (16) K, W. *Burchell* 4015 (5) K; 6139 (5) K; 7321 (9) K.

Calder in SRGH 46276 (16) K. *Cassidy* 22 (5) NBG. *Cloete* in CH 66620 (13) NBG. *Codd* 2716 (16) K, PRE. *Coleman* 521 (16) PRE. *Compton* 4154 (9) BOL., NBG; 4507 (12) BOL., NBG; 4700 (13) BOL.; 9756 (9) NBG; 9759 (9) NBG; 11928 (5) NBG; 11955 (9) NBG; 11993 (5) NBG; 16244 (9) NBG; 16446 (12) NBG; 17486 (6) NBG; 17496 (9) NBG; 18545 (9) NBG; 18609 (9) NBG; 18572 (5) NBG; 19411 (6) NBG; 20090 (5) NBG; 20180 (13) NBG; 20221 (5) NBG; 21729 (16) BOL., NBG; 23670 (5) NBG. *Cutting* s.n. (5) BOL.

Davis & Stokoe in SAM 49539 (9) PRE. *Daly* s.n. (5) PRE. *Dekalen* in CH 57315 (12) NBG. *Devenish* 813 (16) PRE; 1376 (16) PRE. *De Villiers* in NBG 1910/30 (12) BOL.; s.n. (5) STE. *Doidge* 4802 (16) K. *Drège* 1252a (9) BM, G. K, P, S; 1252b (9) BM, K, P; 1261b (5) BM, G, K, P, W; 8290 (12) K; in SAM 21998 (13) SAM. *Drège* 94 (5) Z. *Dünmer* 547 (13) BM; 554a (6) BM; 934 (9) BM; s.n. (5) BM.

Ebersohn 151 (10) NBG; 152 (12) NBG. *Ecklon* 247 (5) M. *Eindon* 30 (12) STE. *Esterhuysen* 400 (5) NBG; 493 (5) NBG; 6175 (9) BOL., PRE; 6396 (9) BOL., PRE; 6543 (9) BOL.; 6882 (16) BOL.; 7086 (16) BOL.; 8206 (9) BOL.; 9025 (5) BOL.; 9780 (10) BOL.; 10573 (12) BOL.; 10692 (16) BOL.; 10925 (9) BOL.; 10999 (9) BOL.; 11194 (6) BOL.; 11693 (5) NBG; 12074 (5) BOL.; 12200 (9) BOL., PRE; 13313 (16) BOL.; 16200 (9) BOL.; 18979a (15) BOL.; 21978 (5) BOL.; 23635 (12) BOL.; 31166 (9) BOL.; in SAM 54324 (2) SAM.

Fannin 33 (16) K. *Farnham* s.n. (5) BOL. *Flanagan* 1687 (16) BOL., PRE; 1807 (16) BOL., PRE, SAM. *Fourcade* 519a (6) K; 1458 (15) K, STE; 1626 (9) BOL.; 2840 (12) K, STE; 2848 (16) K; 3446 (5) K, STE, *Franklin* 40 (16) NU. *Frowien* in PRE 15649 (5) PRE. *Fry sub Galpin* 2719 (16) PRE.

Galpin 308 (16) PRE; 2719 (16) PRE; 4605 (9) GRA, K, PRE; 4606 (5) K, PRE; 4607 (5) K, PRE; 4608 (12) PRE; 4609 (9) BOL., K; 4610 (12) BOL., PRE; 4612 (6) PRE. *Garside* 210 (9) K; 1058 (5) K; 1696 (5) K. *Gillet* 982 (12) STE; 1352 (5) STE; 1783 (9) STE; 1842 (6) STE; 1856 (5) STE; 2091 (5) STE; 2094 (12) STE; 4565 (15) BOL.; 4573 (5) BOL. *Glass* 617 (16) Z. *Goatcher* in BOL 6862 (6) Z. *Goldblatt* 324 (11) BOL. *Gordon* s.n. (16) PRE. *Gueinzus* 264 (16) P. *Guthrie* 725 (1) BOL.; 1082 (9) NBG; 2729 (14) BOL.; in BOL 7096 (6) BOL.; in BOL 7097 (2) BOL., K.

Häfstrom & Acocks 2089 (9) PRE. *Hall* 419 (16) BOL.; 736 (5) BOL.; 737 (5) BOL.; 1068 (5) BOL.; 1073 (5) BOL.; 1081 (5) BOL.; 1104 (16) BOL.; 1116 (16) BOL.; 1122 (5) BOL.; 1194 (9) BOL. *Hallack* in BOL 6093 (16) BOL., K. *Hanekein* 1264 (9) PRE; 2176 (13) PRE. *Harvey* 141 (5) K. *Haygarth* in PRE 22340 (16) K, PRE, Z. *Haynes Palmer* in CH 57305 (4) NBG. *Hilliard* 1695 (16) NU; 5583 (16) NU. *Hilliard & Burt* 8028 (16) NU. *Holland* 3739 (16) BOL. *Horrocks* 28 (5) NBG. *Humbert* 13642 (16) P. *Hutchinson* 575 (9) BM, K, PRE; 672 (6) K; 1225 (5) K; 1412a (15) K; 1432 (16) BOL., K.

Jackson in CH 85840 (12) NBG; in CH 86427 (3) NBG. *Jacobsen* 3720 (16) PRE; 3815 (16) K, PRE. *Jacobsz* 109a (16) PRE; 2/62 (16) PRE. *Jacot Guillarmod*, *Gelliffe* and *Mzamani* 184 (16) K, PRE. *Jeppe* in PRE 33400 (6) PRE; 33401 (15) PRE; 33402 (16) PRE; 33403 (5) PRE; 33404 (12). PRE. *Jordaan* (5) STE.

Kassner 1374 (16) P; 1479 (5) P. *Keet* 1024 (12) PRE. *Kellerman* 26 (13) STE. *Kies* in CH 57316 (10) NBG. *Killick* 3858 (16) PRE; 3873 (16) PRE. *Killick & Vahrmeijer* 3631 (16) PRE. *Krige* in BOL 13491 (6) BOL. *Kruger* 29 (5) STE; 508 (4) STE; 556 (5) STE; 1001 (9) STE; 1072 (12) STE.

Lamb s.n. (13) BOL. *Laughton* 77 (5) BOL.; 79 (5) BOL. *Lavranos* 9380 (16) PRE; 15232 (16) PRE. *Leighton* 840 (8) SAM; 1344 (9) BOL., PRE; 1441 (6) BOL.; 1499 (5) BOL.; 2079 (5) BOL.; 2151 (9) BOL.; 3146 (11) BOL. *Leipoldt* 3236 (11) BOL.; 3237 (5) BOL.; 3809 (14) BOL., K; s.n. (5) BOL. *Le Sueur* in BOL 4973 (14) BOL. *Lewis* 93 (5) SAM; 648 (5) SAM; 721 (13) SAM; 722 (12) SAM; 787 (5) SAM; 788 (13) SAM; 816 (5) SAM; 823 (5) SAM; 850 (6) SAM; 851 (8) SAM; 1094 (13) SAM; 1095 (4) SAM; 1096 (5) SAM; 1097 (5) SAM; 1098 (6) SAM; 1099 (6) SAM; 1100 (6) SAM; 1101 (11) SAM; 1107 (6) SAM; 1108 (2) SAM; 1487 (1) SAM; 1490 (8) SAM; 1832 (13) SAM; 1833 (6) SAM; 2403 (14) SAM; 3546 (6) SAM; 3547 (5) SAM; 3548 (6) SAM; 3549 (13) SAM; 4389 (5) SAM; 4455 (2) SAM; 4756 (5) SAM; 4757 (8) SAM; 4758 (10) SAM; 4759 (6) SAM; 4760 (5) SAM; 5020 (9) SAM; 5542 (11) NBG; 5645 (9) NBG; 6161 (5) NBG; s.n. (11) BOL. *Linder* 752 (8) BOL.; 763 (5)

BOL.; 811 (16) BOL.; 831 (16) BOL.; 841 (16) BOL.; 934 (16) BR, BOL.; 943 (16) BOL.; 973 (16) BOL.; 996 (16) BR; 1000 (16) BOL.; 1129 (11) BOL.; 1140 (11) BOL.; 1149 (9) BOL.; 1243 (5) BOL.; 1479 (9) BOL.; 1507 (4) BOL.; 1508 (3) BOL.; 1509 (11) BOL.; 1510 (3–11) BOL.; 1512 (11) BOL.; 1513 (6) BOL.; 1519 (5) BOL.; 1524 (12) BOL.; 1528 (2) BOL.; 1536 (6) BOL.; 1537 (5) BOL.; 1551 (5) BOL.; 1552 (16) BOL.; 1563 (5) BOL.; 1564 (15) BOL.; 1570 (16) BOL.; 1571 (12) BOL.; 1578 (12) BOL.; 1580 (5) BOL.; 1583 (5) BOL.; 1596 (12) BOL.; 1599 (5) BOL.; 1601 (9) BR, BOL.; 1608 (12) BOL.; 1610 (13) BOL.; 1617 (7) BOL.; 1694 (10) BOL.; 1706 (12) BOL.; 1742 (9) BR, BOL.; 1745 (5) BOL.; 1748 (10) BOL.; 1807 (2) BOL.; 1988 (16) BOL.; 2078 (16) BOL. *Linley* in SAM 49536 (12) PRE, SAM; in SAM 49537 (9) SAM; 49538 (9) SAM; in SAM 49541 (9) SAM; in SAM 56094 (8) SAM; in SAM 56898 (13) SAM; in SAM 56902 (5) SAM; in SAM 56903 (5) SAM; in SAM 56904 (6) SAM; in SAM 56908 (6) SAM; in SAM 61249 (10) SAM. *Liversidge* 232 (16) NBG. *Long* 163 (5) K; 164 (5) K; 827 (5) K, PRE; 835 (16) K, PRE.

MacOwan 381 (5) K, SAM; 679 (16) BM, K, SAM, W, Z, ZT. *MacOwan & Bolus* 170 (9) BM, BOL., G, K, P, SAM, W, ZT; 171 (12) BM, BOL., G, K, P, W, ZT; 1374 (3) BOL., SAM. *Mann* 55 (5) K. *Manning* in CH 87243 (12) NBG. *Maraš* 55 (16) PRE. *Marloth* 61 (9) PRE; 230 (12) PRE; 664 (9) PRE; 1768 (12) PRE; 1854 (11) PRE; 1864 (9) PRE; 4972 (6) BOL.; 8916 (5) PRE. *Matheson* in SAM 59669 (16) SAM. *Mauve* 4761 (12) PRE. *McLoughlin* 12 (16) BOL.; 42 (16) BOL.; 164 (16) BOL.; 403 (16) BOL.; 488 (16) BOL.; in PRE 26260 (16) BOL., K. PRE. *Meebold* 11895 (5) M. *Minicki* in SAM 59671 (2) SAM. *Moll* 2218 (16) PRE. *Moore* s.n. (16) BOL. *Morze* 2026 (5) BOL.; 2027 (5) BOL. *Moss* 4141 (5) K; 19257 (5) K. *Muir* 664 (12) PRE; 746 (5) PRE; 748 (5) PRE; 1124 (12) PRE; 1125 (9) PRE; 1795 (6) PRE; 2330 (9) PRE; 2331 (9) PRE; 2332 (9) PRE.

O'Brien s.n. (16) K. *O'Connor* 213 (16) NU; 214 (16) NU; 296 (16) NU; 334 (16) NU. *Oliver* 3942 (9) STE; 4202 (5) STE; 4761 (14) K, PRE, STE; 5088 (9) PRE; 5370 (9) PRE, STE; 5438 (5) STE; 5447 (9) PRE, STE; 5591 (9) STE; 6044 (9) STE; s.n. (5) BOL.; s.n. (9) BOL.

Page in BOL. 16232 (6) BOL. *Pappe* in SAM 21989 (5) SAM; in SAM 21990 (5) K, SAM; in SAM 21985 (6) SAM; in SAM 21993 (14) SAM; s.n. (12) K. *Paterson* s.n. (5) BOL. PRE. *Penfold* 163 (5) NBG; in CH 57311 (11) NBG. *Penther* 46 (5) M; 53 (16) W; 57 (16) W; 60 (12) W; 65 (16) S, W; 81 (16) W; 99 (12) W; 104 (5) M; 179 (12) W; 186 (8) W; 215 (16) W; 236 (5) W; 277 (5) W; 329 (5) W. *Phillips* 1335 (5) SAM; 1337 (9) SAM; 1341 (12) SAM; 1852 (5) SAM. *Phillips* s.n. (5) BOL. *Phipps* 666 (16) K. *Pillans* 2748 (5) PRE; 2748b (6) PRE; 8483 (5) BOL.; 9176 (5) BOL.; 9324 (5) BOL. *Pocock* 503 (9) STE. *Porter* in CH 57313 (12) NBG. *Prentice* in SAM 10789 (14) SAM; in SAM 10790 (9) SAM; in SAM 10791 (9) SAM. *Prinos* *sub Marloth* 11705 (9) PRE. *Purcell* 424 (9) STE; in SAM 91219 (5) SAM; in SAM 91220 (5) SAM.

Rabinowitz in CH 57307 (14) NBG; in CH 77143 (14) NBG. *Ratray* in BOL 15784 (16) BOL. *Rehmann* 581 (8) Z; 582 (5) Z; 1950 (9) M. *Rogers* 2824 (16) Z; 17735 (5) Z; 23633 (5) PRE; 26494 (5) Z; 26569 (5) Z; 27166 (5) Z; 27970 (16) Z; 29057 (8) K; s.n. (13) K. *Rudatis* 565 (16) STE; 784 (16) BM, K.

Salter 8290 (12) K; 8473 (12) BOL.; 8479 (13) BOL.; 8554 (3) SAM; 9374 (5) BM; 322/15 (6) BM; 322/17 (2) BM; 323/2 (12) BM; 323/5 (13) BM; in SAM 55850 (5) SAM. *Sanderson* 894 (16) BOL.; 938 (5) K; s.n. (16) K. *Saunders* s.n. (16) BOL. *Schelpel* 132 (16) NU; 4227 (5) BM; 4882 (11) BOL.; 4895 (5) BOL.; 4979 (5) BOL.; 6328 (16) BOL., K; 7114 (16) BOL.; 7118 (5) BOL.; 7155 (16) BOL.; 7162 (16) BOL. *Schlechter* 1479 (6) G, K, M, P, W, Z; 1550 (13) BM, G, GRA, K, S, W, Z; 4713 (16) BOL., K, P, PRE, W, Z; 5167 (11) BOL.; 5791 (8) BOL., Z; 5958 (6) BOL., K, PRE; 5965 (5) BM, G, K, P, PRE, W, Z; 5974 (16) BM, K, Z; 9501 (4) BOL.; 9502 (8) BOL.; 9618 (2) BM, BOL., G, K, P, PRE, Z. *Schmidt* 606 (5) M; 607 (5) M. *Schonland* 610 (5) PRE. *Schur* in CH 57290 (6) NBG. *Scully* in BOL 4903 (10) BOL. *Seltzer* in CH 57304 (5) NBG. *Sinn* 856 (16) NU; 864 (16) NU. *Sinith* 4871 (5) PRE. *South* 617 (16) PRE. *Stokoe* 241 (12) PRE; 1151 (9) PRE; 6764 (9) BOL.; 7382 (15) BOL.; 9065 (9) BOL.; in BOL 16649 (12) BOL.; in BOL 17531 (4) BOL.; in BOL 18388 (9) BOL.; in CH 9904 (10) NBG; in SAM 36760 (13) SAM; in SAM 49534 (5) SAM; in SAM 49539 (9) SAM; in SAM 49540 (9) SAM; in SAM 55884 (9) SAM; in SAM 57747 (12) SAM; in SAM 57748 (9) SAM; in SAM 57749 (9) SAM; in SAM 57750 (5) SAM; in SAM 59668 (3) SAM; in SAM 61248 (5) SAM; in SAM 61250 (13) SAM; in SAM 63158 (5) SAM; in SAM 63159 (9) SAM; in SAM 63759 (12) SAM; in SAM 65620 (5) SAM; in SAM 68251 (9) SAM; *sub Marloth* 10569 (9) PRE; s.n. (4); s.n. (9) BOL.; s.n. (9) BOL.; s.n. (10) BOL.; s.n. (10) BOL. *Strauss* 33 (11) NBG.

Taylor 247 (6) BOL.; 252 (10) BOL.; 258 (12) BOL.; 6462 (9) STE. *Thode* A1021 (5) PRE; A2285 (5) PRE; in STE 3836 (16) STE; in STE 5427 (5) STE; in STE 6108 (5) STE; in STE 6110 (12) STE; in STE 8138 (16) STE. *Thomas* in CH 56374 (3) NBG. *Thoms* s.n. (5)

M. Thompson 3220 (5) STE. *Trauseld* 569 (16) PRE; 983 (16) PRE. *Trinen* s.n. (13) BM. *Truter* s.n. (13) STE.

Vahrmeijer 1062 (16) PRE. *Van Niekerk* 191 (5) BOL. *Verreaux* s.n. (5) G.

Wall 2228 (8) S; s.n. (5) S; s.n. (16) S. *Walters* 508 (5) BOL; 534 (8) BOL; 536 (15) BOL. *Wasserfall* 972 (5) K, PRE. *Werdermann & Oberdieck* 139 (5) PRE. *Wild* 938 (16) K. *Wilson* in SAM 21999 (13) SAM. *Winkler* 30 (5) NBG; 5049 (5) NBG. *White* 610 (5) Z. *Wolley-Dod* 394 (5) BM, BOL; 1788 (9) K; 1845 (5) K; 1846 (13)

BM; 2179 (8) BOL; 2992 (12) BOL, K; 3066 (13) BM, BOL; 3067 (12) BM, BOL, K; 3212 (6) K; 3506 (9) BOL; 3587 (6) BOL, K; 3601 (6) BM; 3602 (5) BM; 3635 (15) BOL, K; 5636 (4) BM, BOL. *Wood* 12254 (16) PRE; 12257 (16) SAM, Z. *Worsdell* 54b (5) K. *Wright* 135 (5) K; 2377 (16) NU. *Wurts* 436 (5) NBG; 2039 (5) NBG.

Zeyher 242 (12) K; 1564 (6) G, K, PRE, SAM, W; 1569 (15) BOL, K, SAM; 1570 (13) BOL, G, K, SAM, W; 3924 (12) BM, K, P, SAM, W; 3925 (9) BM, K, S, SAM, W; 4680 BOL, K, P, PRE, SAM.

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Taxonomic studies in the Disinae. VI. A revision of the genus *Herschelia*

H. P. LINDER*

ABSTRACT

The genus *Herschelia* (Disinae, Orchidaceae) is revised. Sixteen species, one subspecies and one variety are recognized. Two new species from tropical Africa (*H. chimanimaniensis* Linder and *H. praecox* Linder) and a new variety from the Cape Province *H. lugens* (H. Bol.) Kraenzl. var. *nigrescens* Linder are described. Three new combinations are made by transferring the two species of *Forficaria* and *Disa* sect. *Microperistera* (one species) to *Herschelia*. Thirteen species are illustrated, and the nomenclature and the available information about the habitats of the taxa are discussed. The species are grouped into two subgenera, one of which is further divided into two sections and four series. This classification is based on the putative phylogeny, as determined by the method devised by Wagner (1962).

RÉSUMÉ

ÉTUDES TAXONOMIQUES DES DISINAE. VI. UNE RÉVISION DU GENRE HERSCHELIA

Le genre *Herschelia* (Disinae, Orchidaceae) est révisé. Seize espèces, une sous-espèce et une variété sont reconnues. Deux nouvelles espèces d'Afrique tropicale (*H. chimanimaniensis* Linder et *H. praecox* Linder) et une nouvelle variété originaire de la province du Cap, *H. lugens*, (*H. Bol.*) Kraenzl. var. *nigrescens* Linder sont décrites. Trois nouvelles combinaisons sont faites en transférant les deux espèces de *Forficaria* et *Disa* sect. *Microperistera* (une espèce) à *Herschelia*. Treize espèces sont illustrées, et la nomenclature ainsi que l'information disponible quant à leurs habitats et taxa sont discutées. Les espèces sont groupées en deux sous-genres, une desquelles est de plus divisée en deux sections et quatre séries. Cette classification est basée sur la phylogénie putative, déterminée selon la méthode décrite par Wagner (1962).

INTRODUCTION AND HISTORICAL OVERVIEW

Herschelia is one of the 'minor' genera in the subtribe Disinae (Orchidoideae, Orchidaceae). The genus is centred in the Cape Floral Region (Goldblatt, 1978), where 12 of the 16 species occur. The remaining four species occur in the montane grasslands (White, 1978) of southern and south-central Africa, extending marginally into East Africa (Robyns & Tournay, 1955).

There has been a conspicuous lack of consensus about the delimitation of the genus and the species. Lindley, who describe the genus in 1838, included only *H. graminifolia* in it, and placed the other known species into *Disa* sect. *Trichochila*. This treatment was followed by Bentham & Hooker (1883) and Pfitzer (1889). Harry Bolus transferred all the then known species to *Herschelia*, which he treated as a section of *Disa*. Schlechter (1901) followed a similar approach. Bolus provided descriptions and illustrations for the majority of the species, and did excellent work on the nomenclature and morphology of various species in the group (1882, 1889, 1893, et seq.). Although Rolfe (1913), Schelpe (1966) and Dyer (1976) essentially follow the generic delimitations of Bolus and Schlechter, they treat *Herschelia* as a genus. *Forficaria* has generally been regarded as allied to *Herschelia* (or to *Disa* sect. *Trichochila*), but has never been included in the same group. Kraenzlin (1900) produced a rather artificial treatment, where *H. spathulata* s.l., and *Disa lacera* are removed from *Herschelia*, and grouped with *Disa cooperi*, *D. sculpii* and *D. thodei* in *Disa* sect. *Spathulatae*.

Several species of this genus have from time to time been introduced into cultivation in Europe, but there is little evidence that the plants lasted more than a few seasons. According to Hooker (1886, 1889), *H. hians* and *H. spathulata* subsp. *spathulata* flowered at Kew. In 1905 it was noted that *H. graminifolia*, *H. spathulata* and an unknown species of *Herschelia*

were in cultivation (Anon., 1905). In 1912 Rolfe remarked: 'Though the species (*H. lugens*) has been repeatedly introduced to cultivation in this country, it is by no means easy to maintain in good condition, owing to its tendency to dwindle away after flowering'. In 1955 Dyer remarked that attempts to introduce *H. graminifolia* were still unsuccessful and that all tuberous orchids fared badly in cultivation. At present several species (*H. spathulata* subsp. *spathulata*, *H. lugens*, *H. purpurascens*, *H. barbata* and *H. graminifolia*) are in cultivation in South Africa. It is to be hoped that methods of propagating these species may soon be perfected, as several of the more striking species are already rare in nature, and may soon, if present trends continue, become extinct.

MORPHOLOGY

In general, the habit of all the species of *Herschelia* is grass-like with a radical tuft of linear, usually rolled, erect leaves, and a slender erect stem. The vegetative structures in this genus appear to be well adapted to the various ecological preferences and phenology of the species, within the framework of the general grass-like structure.

The tubers are rather variable in size and are often remarkably large for the size of the plants. Large tubers are often found on plants collected from well-drained sandy areas.

The radical leaves display three patterns:

- (a) In the winter-rainfall and all-the-year rainfall regions, the majority of the species have linear, rolled, erect leaves that are produced before the flowers, and that may be dry or green at anthesis. The leaves do not reach above the base of the inflorescence, presumably as this would obscure the lower flowers from any pollinators.
- (b) In the winter-rainfall region, the *H. spathulata* group has flat leaves. The plant is early flowering, before the summer drought starts, and the flat leaves may reflect the absence of xeric adaptations.

*Bolus Herbarium, University of Cape Town, Rondebosch, 7700.

fida). Spathulate lips also evolved twice: in *H. multifida* and in ser. *Spathulatae*.

The column in *Herschelia* is, to a certain extent, characteristic of the genus. Typically the anther is horizontal, usually with two large viscidia (these may, however, be fused), the rostellum erect, with three equal lanceolate, acute lobes, holding the viscidia between them (Bulus, 1882) and a horizontal, shortly pedicellate stigma with three lobes, the rear or odd lobe much smaller than the lateral lobes. The rostellum and stigma structures are variable, but unfortunately it is rather difficult to get a clear picture of these structures from dried material. Frequently the rostellum consists of two lateral horns, which are canaliculate and hold the viscidia at their apices. The central lobe appears to be highly reduced or lost. It is possible that the central lobe could be formed by the fusion of the inner walls of the canaliculate lateral rostellum horns. This suggestion is made more likely by the fact that the inner rostellum lobe is frequently bilobed or bifid. This would indicate that the trilobed rostellum is derived from the bilobed canaliculate rostellum. Variation in the stigma structure affects the size of the odd lobe, which varies from large as the lateral lobes to much smaller.

The occurrence of taxonomically important characters in the genus is indicated in Table 1.

PHYLOGENY

The construction of a putative phylogeny for the genus is basic to the production of a phylogenetic classification of the species (Funk & Stuessy, 1978). Objective methods for the construction of phylogenies have been proposed by Hennig (1966), Wagner (1962) and several others, and are ably reviewed by Funk & Stuessy (1978) and Bremer & Wanntrop (1978). Essentially, the derived and generalized character states for the taxonomically important characters are postulated, and groups of species are formed on the number of shared derived character states. By using the Wagner method (Wagner, 1962) the more specialized taxa in the genus may be identified.

The determination of derived character states is based on two processes (Bremer & Wanntrop, 1978): detection of transformation series in a structure and determining the distribution of the character state in related groups. Generalized character states are likely to be wide-spread in related groups (Judd, 1979). This analysis was applied to the variation in the lip shape, petal apex shape, spur shape and flower col-

our. In lip and petal apex shape there are clear transformation series from simple entire structures to variously specialized structures. The simple entire structures, especially in the lip shape, are also widespread within the Disinae. The spur shape is more difficult to rank. It is likely that a short semipendent spur is typical for the subtribe, but there is no such structure in *Herschelia*. Consequently, the spurless state is considered to be primitive or generalized. However, this implies that there must have been a reversal in the evolutionary sequence for this structure, as two clearly unrelated taxa (subgen. *Forficaria* and *H. goetzeana*) are spurless. In the flower colour, blue is assumed to be the generalized state. This implies that white flowers evolved twice: in *H. barbata* and *H. schlechterana*. As these two taxa are not closely related, this is thought to be likely. The characters used for the analysis are listed in Table 2. Generalized characters are scored zero, specialized characters one, and intermediate states are scored 0.5. For several characters there are several specialized states.

TABLE 2.—Characters used for the phylogenetic analysis

Character	Generalized state	Specialized state
Spur	absent	short (0.5) or long
sepals	blue	white or red
petals	acute	bifid, lacerate, expanded or aciculate
lip	sessile	stalked
	entire	crenulate (0.5), bearded or trilobed
rostellum	ovate	reniform
flowers	lateral lobes	three horns
	resupinate	not resupinate

The summed values for each taxon are used to place the taxon on the 'Wagner Tree'. Species sharing the largest number of derived or specialized character states are linked first, whereas species sharing no specialized characters are linked to the putative ancestor.

The Wagner Tree (Fig. 1) clearly demonstrates the major groups among the species:

(a) the *H. forficaria* group is highly specialized and quite isolated. The basic structure of the petal and the specialization of the lip, as well as the vegetative characters, indicate that it has to be included in *Herschelia*.

(b) *H. schlechterana* also shares the vegetative and petal structures typical of the genus, but has a

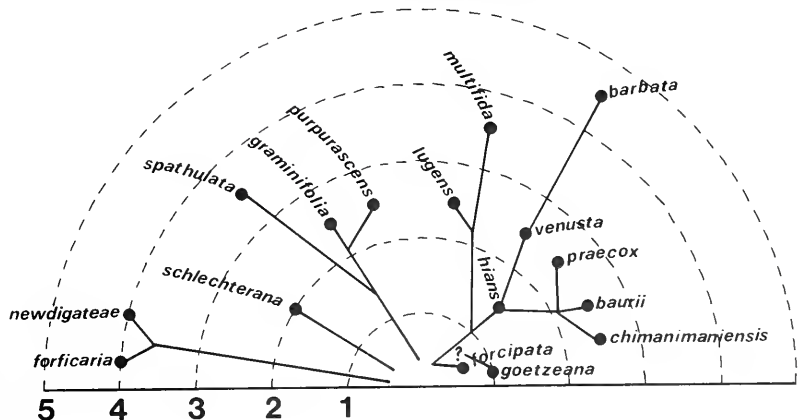


FIG. 1.—Wagner Tree for *Herschelia*. The circles indicate the degree of divergence.

unique spur, white flowers and an entire lip. It may also be derived directly from the ancestral stock of the genus.

(c) The remainder of the genus may be divided into two groups, mainly on the lip and petal apex shapes. *H. spathulata* has a spathulate three-lobed lip, whereas in *H. graminifolia* and *H. purpurascens* the lip is sessile and the lip margins undulate. Both these groups are restricted to the Cape Floral Region (*sensu* Goldblatt, 1978), and show signs of recent, if not ongoing, speciation. The *H. hians* group is characterized by bearded lips. Within the group various lines of development have used different petal shapes. The group may be understood to form a remarkable sequence of geographical and ecologically replacing species. The position of *H. forcipata* is not clear, the species is known only from a single collection. The available data indicate that the taxon may well be ancestral to the group. *H. goetzeana* emerges on the 'Wagner Tree' as being rather primitive. However, it may well be highly specialized, as a reduced form derived from *H. baurii*. At present it is an enigma and is known from a single collection from the summit of Mt Mbeya in southern Tanzania.

HERSCHELIA

Herschelia Lindl., Gen. Sp. Orch. 362 (1838); Benth. & Hook. f., Gen. Pl. 3: 630 (1883); Pfitzer in Natürl. Pflfam. 2,6: 98 (1889); Kraenzl., Orch. Gen. Sp. 1: 801 (1900); Rolfe in Fl. Cap. 5,3: 199 (1913); Senghas in Schltr., Die Orchideen 1: 275 (1973), excl. syn.; Dyer, R.A. Gen. 2: 995 (1976). Type species: *Herschelia coelestis* Lindl. [= *H. graminifolia* (Spreng.) Dur. & Schinz]

Disa Berg. sect. *Herschelia* (Lindl.) H. Bol. in Trans S. Afr. phil. Soc. 5: 168 (1888); Schltr. in Bot. Jb. 31: 282 (1901), excl. *Disa* sect. *Amphigena* in synonymy; Summerh. in Fl. Trop. E. Afr. 156: 154 (1968).

Disa Berg. sect. *Trichochila* Lindl., Gen. Sp. Orch. 353 (1838); Pfitzer in Natürl. Pflfam. 2,6: 98 (1889). Type species: *Disa barbata* (L. f.) Swartz. [= *H. barbata* (L. f.) H. Bol.], lectotype.

Forficaria Lindl., Gen. Sp. Orch. 362 (1838); Benth. & Hook. f., Gen. Pl. 3: 631 (1883); Pfitzer in Natürl. Pflfam. 2,6: 97 (1889); Kraenzl., Orch. Gen. Sp. 1: 722 (1900); Rolfe in Fl. Cap. 5,3: 207 (1913); Senghas in Schltr. Die Orchideen, 1: 271 (1973); R. A. Dyer, Gen. 2: 995 (1976). Type species: *Forficaria graminifolia* Lindl. [= *Herschelia forficaria* (H. Bol.) Linder].

Disa Berg. sect. *Forficaria* (Lindl.) Schltr. in Bot. Jb. 31: 297 (1901).

Disa Berg. sect. *Spathulatae* Kraenzl., Orch. Gen. Sp. 1: 793 (1900). Type species: *Disa spathulata* (L. f.) Swartz [*Herschelia spathulata* (L. f.) Rolfe], lectotype.

Disa Berg. sect. *Microperistera* H. Bol. in Trans. S. Afr. phil. Soc. 16: 149 (1907). Type species: *Disa schlechterana* H. Bol. [= *Herschelia schlechterana* H. Bol.) Linder].

Herschelia is named after Sir John F. W. Herschel (1792–1871), an astronomer who spent some years at the Cape.

Characteristic of this genus are the radical, linear, subsclerophyllous leaves, dry floral bracts, lax inflorescences, the rarely entire lip, usually variously dissected or stalked, petals with a basal anticus lobe, and the limb initially horizontally reflexed, soon falcately or geniculately curved upwards behind the anther, anther horizontal with one or two viscidia, rostellum generally with three equal erect, lanceolate lobes, stigma horizontal, the odd lobe smaller than the lateral lobes.

Plants slender, grass-like, erect 100–1 000 mm tall; tubers testicular, rarely three present, very variable in size, from 10–60 mm long, hirsute; roots unbranched, thick; base of the stem usually with a sheath of old leaf fibres; radical leaves 5–20, linear, flat or rolled, subsclerophyllous, shorter than or longer than the base of the inflorescence, produced during, before or after flowering; cauline leaves lax or imbricate, brown, acuminate, usually longer and overlapping to the base of the stem; inflorescence lax with 1–30 flowers; bracts usually broadly ovate, acuminate to setaceous, dry, varying from half as long as to slightly longer than the ovary; ovaries usually spreading from the stem, slender, 10–30 mm long. Flowers resupinate, usually blue or shades of blue, to white with pale blue veins, rarely purplish red or with green parts; dorsal sepal erect or angled forwards, generally galeate, rounded to acuminate, usually ovate in front view with the galea about half as deep as tall; spur horizontal from the base of the galea, at length straight, decurved or curved upwards, rarely longer than the sepals, cylindrical or conical; lateral sepals usually patent, lanceolate to ovate, obtuse to acute, 6–30 mm long; petals with a basal anticus lobe flanking the stigma, oblong to ovate, and a limb which is linear or lorate, the basal part of which is reflexed to the horizontal, flanking the anther, the apical part of which is curved falcately or geniculately upwards behind or near the apex of the anther, the apex of which may be lanceolate, expanded fan-like or more or less bifid; lip generally more or less dissected, rarely entire, usually ovate in outline, rarely spathulate, always specialized in some way; anther horizontal or somewhat pendent, the two cells parallel, with two viscidia which may be separate or fused; rostellum generally with the three lobes equal, erect, lanceolate, acute, rarely with the lateral lobes canaliculate and the central lobe not present; stigma horizontal, shortly pedicellate, the odd lobe smaller than the lateral lobes, the whole structure usually wider than the rostellum.

Subgen. *Forficaria* (Lindl.) Linder, stat. nov.

Forficaria Lindl., Gen. Sp. Orch. 362 (1838). Type species: *Forficaria graminifolia* Lindl.

Flowers with the lip facing towards the axis, dorsal sepal without a spur, lip reniform.

This subgenus contains two closely related species: *H. forficaria* and *H. newdigatae*, that appear to be vicariants as defined by Davis & Heywood (1963).

KEY TO THE SPECIES

- 1a Lip entire:
- 2a Lip kidney-shaped; petals ciliate:
- 3a Petals obscurely bilobed, flattened; from the southern Cape Province 2. *H. newdigateae*
- 3b Petals acuminate; from the western Cape Province 1. *H. forficaria*
- 2b Lip ovate to lanceolate; petals glabrous:
- 4a Spur 30–35 mm long 3. *H. schlechterana*
- 4b Spur less than 15 mm long:
- 5a Apex of the petals obtriangulate, flabellate, truncate:
- 6a Spur conical, tapering; lip margins curved upwards 6. *H. purpurascens*
- 6b Spur subclavate; lip margins curved downwards 5. *H. graminifolia*
- 5b Apex of the petals acute, entire or bifid:
- 7a Spur bifid 12. *H. forcipata*
- 7b Spur obtuse 11. *H. hians*
- 1b Lip more or less lacerate or bearded:
- 8a Lip stalked:
- 9a Lip blade deeply lacerate 10. *H. multifida*
- 9b Lip blade entire, 3-lobed or ovate:
- 10a Central lobe of lip (12–) 16–22 mm long; from east of Swellendam 4b. *H. spathulata* subsp. *tripartita*
- 10b Central lobe of lip less than 14 mm long; from west of Swellendam 4a. *H. spathulata* subsp. *spathulata*
- 8b Lip sessile:
- 11a Petals deeply bilobed; from north of the Limpopo River:
- 12a Lateral sepals 6–8 mm long; from the Chimanimani Mountains in Zimbabwe ... 15. *H. chinaninaniensis*
- 12b Lateral sepals 8–25 mm long:
- 13a Petals as long as the galea; lip almost entire; from the Nyika Plateau in Malawi 13. *H. praecox*
- 13b Petals about ½ as long as the galea; lip deeply lacerate:
- 14a Spur present 14. *H. baurii*
- 14b Spur absent 16. *H. goetzeana*
- 11b Petals obtriangulate or obscurely bilobed; from south of the Limpopo River:
- 15a Lip longer than the lateral sepals, green or almost black:
- 16a Flower blue to green 9a. *H. lugens* var. *lugens*
- 16b Flower almost black 9b. *H. lugens* var. *nigrescens*
- 15a Lip shorter than the lateral sepals, more or less blue:
- 17a Lateral sepals longer than 15 mm; galea acuminate 7. *H. barbata*
- 17b Lateral sepals less than 16 mm long; galea rarely acuminate:
- 18a Limb of the petal linear, apex somewhat expanded; lateral sepals 12–16 mm long 8. *H. venusta*
- 18b Limb of the petals lorate, apex lanceolate or obtriangulate; lateral sepals less than 13 mm long:
- 19a Petals lanceolate; lip shallowly dissected; from west of Grahamstown 11. *H. hians*
- 19b Petals obtriangulate; lip deeply dissected; from east of Grahamstown 14. *H. baurii*

1. *Herschelia forficaria* (H. Bol.) Linder, comb. nov.

Forficaria graminifolia Lindl., Gen. Sp. Orch. 362 (1838); Kraenzl., Orch. Gen. Sp. 1: 723 (1900); Rolfe in Fl. Cap. 5, 3: 207 (1913). *Disa forficaria* H. Bol., Icones Orch. Austro-Afr. 1: t. 87 (1896), nom. nov. Type: Cape Province, Paarl Division, Du Toit's Kloof, Drège 2211b (K, holo.).

Icon: Flower. Pl. Afr. 11: t. 415 (1931)

Plants up to 500 mm tall; tubers c. 50 mm long; stems often with a sheath of old leaf fibres around the base; radical leaves linear, erect, reaching to the base of the inflorescence, acute; cauline leaves lax, narrowly ovate, acuminate, 20–40 mm long; inflorescence lax, c. 100 mm long; bracts shorter than the ovaries, ovate, acuminate, dry; ovaries c. 15 mm long. Flowers twisted through 360°, sepals greenish red, petals and lip deep maroon; dorsal sepal erect to reflexed at anthesis, deeply concave, orbicular, apiculate, 8–12 mm in diameter; lateral sepals patent

narrowly ovate, acute to shortly acuminate, shallowly concave, 8–12 mm long; petals with the basal half lorate, reflexed parallel to the anther, 4–6 mm long, the apical half acuminate, geniculate bent forwards, terete, acute, tomentose; lip reniform, patent, 4–5 mm long and c. 6 mm wide, the distant margin somewhat swollen and shortly villose; anther horizontal, 4–5 mm long, caudicles short; rostellum small with well-developed staminodes; stigma pedicellate, almost equally trilobed. Fig. 2.

Diagnostic features. Dorsal sepal spurless, lip reniform, petal apex almost setaceous and tomentose, flowers twisted through 360°.

Flowering time: January and February.

A rare reed-like plant that occurs on well-drained gravelly slopes in the Caledon and Cape Peninsula Division (Fig. 3).

*In the treatment of each taxon only representative specimens have been cited. A full list of all specimens studied is given in the Appendix, pp. 387–388.

CAPE.*—3418 (Simonstown): Klaver Valley (—AB), Jan. 1922, Pillans 4125 (BOL). 3419 (Caledon): Viljoenspass (—AA), Feb. 1933, McGilllett 718 (BOL).

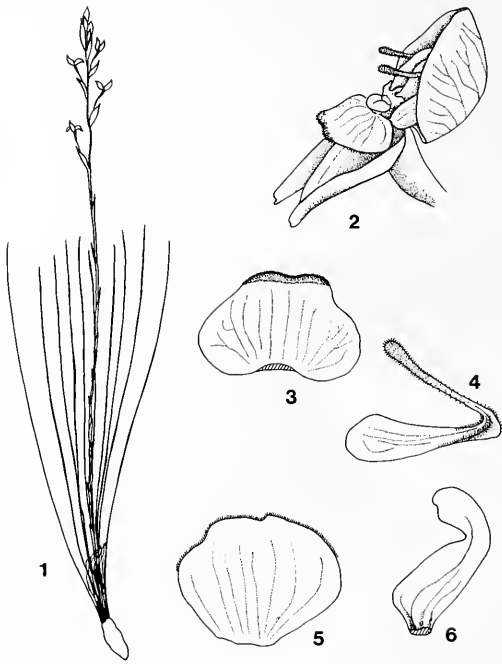


FIG. 2.—*Herschelia forficaria* (1–4) and *H. newdigateae* (5–6). 1, habit, $\times 0.25$, from Gillett 718. 2, flower, $\times 3$. 3, lip, $\times 5$. 4, petal, $\times 5$ (2–5 from Rosenbruck s.n.) 5, lip of *H. newdigateae*, $\times 5$. 6, petal, $\times 5$. (5 & 6 from Bolus 6327.)

Very little is known about this rather peculiar species. It appears to grow on well-drained gravelly mountain slopes, but I have not succeeded in finding any populations in the field. Several collections were made shortly after veld fires, but this may be due merely to the greater ease of finding these rather cryptic plants in the restioid vegetation that dominates the habitat. The plants occur singly and widely scattered. The altitude range of the species is from about 100 m to 600 m. Rainfall is concentrated in the winter months, and totals about 800 mm p.a. (Jackson, 1961).

The specific epithet '*graminifolia*', under which the species is commonly known, cannot be transferred to *Disa* nor to *Herschelia*, as Sprengel described a *Disa graminifolia* in 1826, which Durand and Schinz transferred to *Herschelia* (1894). When Bolus (1896) transferred *Forficaria graminifolia* to *Disa*, he proposed *D. forficaria* as a *nomen novum*. This epithet is here transferred to *Herschelia*.

2. *Herschelia newdigateae* (L. Bol.) Linder, comb. nov.

Disa newdigateae L. Bol. in Flower. Pl. Afr. 11: t. 415 (1931). Type: Cape Province, Knysna, Forest Hall, *Newdigate* in BOL 6327 (BOL, holo.!).

Icon: H. Bol., Icones Orch. Austro-Afr. 1: t. 87 (1896), as *Disa forficaria*.

Plants up to 500 mm tall, radical leaves linear, acute up to 300 mm long; cauline leaves lax to subimbricate, acuminate, 30–50 mm long, completely sheathing; inflorescence lax, c. 100 mm long; bracts about as long as the ovaries, acuminate, narrowly ovate; ovaries c. 15 mm long. *Flowers* not resupinate; sepals greenish red, petals and lip deep maroon; dorsal sepal somewhat spatulate with a very short limb, the blade deeply concave, orbicular, apiculate, c. 8 mm in diameter, the margin somewhat dentate; lateral sepals ovate, acute, concave, c. 8 mm long; petals with the basal 4 mm narrowly ovate, parallel to the anther, the apical $\frac{1}{3}$ curved up behind the anther, somewhat expanded apically and shallowly bilobed, tomentose; lip reniform, 4 mm long and 6 mm wide with the front margin ciliate; anther horizontal, c. 2 mm long; rostellum with the lateral lobes canaliculate, very small, central lobe apparently obsolete, viscidia big; stigma horizontal, flat. Fig. 2.

Diagnostic features. Dorsal sepal spurless, lip reniform, petal apex somewhat flattened and shallowly bilobed, tomentose, ovary not twisted.

Flowering time: March–April.

Very rare in the area between Nature's Valley and Plettenberg Bay (Fig. 3), from where it is only known from two collections. It grows on dry slopes in short macchia vegetation facing the sea. Superficially this species resembles *H. forficaria*, but a study of the flower soon reveals several distinguishing characters (shape of petal and galea, apex of lip and relative length of anther. Fig. 2). These two taxa are clearly eco-geographic vicariants.

The differences between the two taxa were not observed by the several taxonomists, who had studied the available material. Bolus (1896) published an illustration of *H. newdigateae* under the name *H. forficaria*. It was only when more fresh material of *H. forficaria* became available that the differences between the taxa were detected.

Subgen. *Herschelia*

Flowers resupinate, dorsal sepals (with one exception) spurred, lip more or less ovate and generally lacerate.

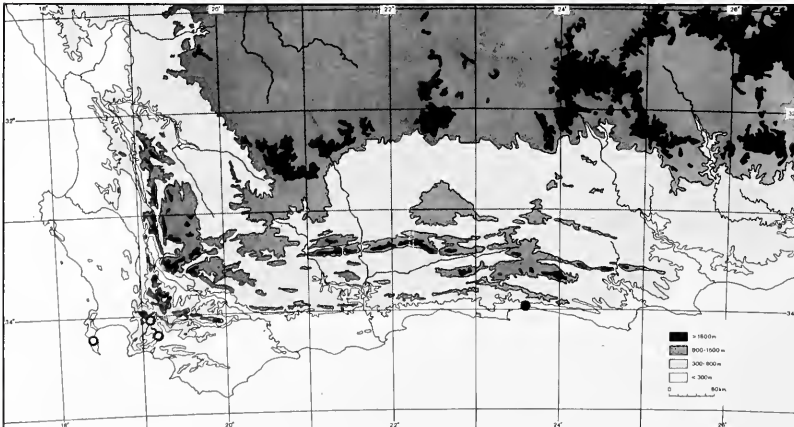


FIG. 3.—Distribution of *H. forficaria* (open circles) and *H. newdigateae* (closed circles).

Type species: *H. graninifolia* (Spreng.) Dur. & Schinz.

This subgenus contains those species which have traditionally been placed in *Herschelia* and which are often popularly known as 'Blue Disas'. The group contains a wide range of forms and is here further subdivided.

Sect. **Microperistera** *H. Bol.* in Trans. S. Afr. phil. Soc. 16: 149 (1907).

Type species: *Herschelia schlechterana* (H. Bol.) Linder.

Lip entire, sessile, ovate, spur longer than sepals.

3. ***Herschelia schlechterana* (H. Bol.) Linder**, comb. nov.

Disa schlechterana H. Bol. in Trans. S. Afr. phil. Soc. 16: 149 (1907); Rolfe in Fl. Cap. 5,3: 250 (1913). Type: Cape Province, Riversdale District, Garcias Pass *Luyt* in BOL 10571 (BOL, holo.!; BM!; BR!; K!; W!).

Icon: H. Bolus, Icones Orch. Austro-Afr. 2: t. 75 (1911).

Plants about 600 mm tall; tubers c. 4 mm long and 15 mm in diameter; base of the stem often with the fibrous remains of old leaves; radical leaves about 10, 300–400 mm long and about 2 mm wide, sulcate, the inner leaf surface smooth and the outer ridged longitudinally; cauline leaves about 9, lax or subimbricate, completely sheathing, dry, acute, 30–50 mm long; inflorescence lax, 100–200 mm long and with 3–12 flowers; bracts about $\frac{2}{3}$ as long as the ovaries, lanceolate, acuminate, dry; ovaries about 30 mm long at anthesis, slightly curved. *Flowers* cream with mauve veins; dorsal sepal erect, galea obtuse, 22–25 mm tall, c. 16 mm wide and 8 mm deep, the margins curved outwards; spur from a shortly conical base, horizontal at the base and at length gradually decurved, slender cylindrical, subacute, 30–50 mm long; lateral sepals patent, lanceolate to narrowly oblong, suboblique acute 20–25 mm long, aciculus 0.5–1 mm long; petals with the basal anticus lobe orbicular, c. 3 mm in diameter, decurrent with the limb of the petal, limb loriate, 14 mm long, the basal part horizontal, soon geniculately curved through 135° to face forwards, the apex lanceolate, acute; lip patent, flat, narrowly oblong to loriate, acute, 15–20 mm long; anther somewhat pendent, 4.5 mm long with two globular viscidia; rostellum equally 3-lobed, 4 mm tall; stigma unequally 3-lobed, the odd lobe smaller than the lateral lobes, horizontal and c. 3 mm in diameter.

Diagnostic features. Flowers large, lateral sepals 20–25 mm long, spur 30–35 mm long; lip entire, narrowly oblong to loriate.

Flowering time: December.

This striking species has only been recorded from the dry north-facing slopes of the Langeberg (Fig. 4) in the vicinity of Riversdale, where it appears to grow amongst the sclerophyll bush in moister places.

CAPE.—3321 (Ladismith): Garcias Pass (—CC), Dec. 1930, *Ferguson* s.n. (BOL).

Sect. **Herschelia**

Lip sessile or stalked, usually lacerate, spur shorter than the sepals.

Type species: *H. graninifolia* (Spreng.) Dur. & Schinz.

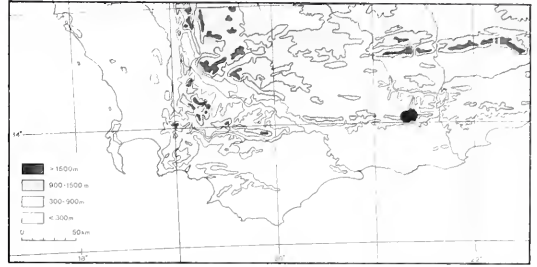


FIG. 4.—Distribution of *H. schlechterana*.

Within this section four clear groups may be recognized, mainly on the basis of petal and lip morphology, and secondarily on the shape of the spur. The exact relationships among these series is not clear, but it is likely that ser. *Spathulatae* and ser. *Herschelia* are closely related rather than to ser. *Hians* and ser. *Ecalcaratae*. The former two series both occur in the western Cape Province and have expanded apical petal lobes and non-lacerate lips, whereas the latter two sections have lacerate lips and extend into East Africa.

Ser. ***Spathulatae* (Kraenzl.) Linder**, stat. nov.

Disa sect. *Spathulatae* Kraenzl., Gen. Sp. Orch. 1: 793 (1900).

Type species: *H. spathulata* (L. f.) Rolfe, lectotype.

Lip spathulate, with a short or long stalk and the apical lobe obtusely trilobed to deeply trifid, petals expanded apically.

This series contains a single species complex and is restricted to the western and southern Cape Province.

4. ***Herschelia spathulata* (L. f.) Rolfe** in Fl. Cap. 5,3: 205 (1913). Type: Cape of Good Hope, *Thunberg* s.n. (LINN, holo.!; UPS!; W!).

Plants 120–300 mm tall, tubers 15–30 mm long; base of the stems often with a sheath of fibrous leaf remains; basal sheaths 2–3, hyaline, acute radical leaves 5–20, linear, 50–150 mm long and 2–4 mm wide, narrower towards the base, semi-erect, curved falcately; cauline leaves (2–) 3, dry, 20–30 mm long, completely sheathing, acuminate, grading to the floral bracts; inflorescence laxly 1–5-flowered, up to 100 mm long; bracts varying from half as long as the ovary to longer than the ovary, broadly ovate, acuminate to setaceous, dry; ovaries straight or slightly curved, 15–30 mm long. *Flowers* variable in colour from maroon to pale lime or green and blue; dorsal sepal erect, subspathulate, the limb horizontal, 1–3 mm long, the blade usually galeate, rarely flat, erect, 9–17–20 mm long, broadly ovate, obtuse, usually 5 mm deep; spur usually clavate, rarely cylindrical, obtuse, straight or strongly curved downwards, 1.5–3 mm long; lateral sepals patent or curved up in front of the flowers, narrowly ovate to ovate, oblique, acute the apical part conduplicate, 6–16 mm long; petals with the basal anticus lobe oblong, 3 mm long, decurrent with the limb; petal limb linear to loriate, 7–12 mm long, the basal part parallel to the anther, the apical part curved upwards behind the anther, the apex dilated, unequally bilobed, up to 4 mm wide; lip spathulate, the claw linear, 5–35 mm long and 1–2 mm wide, the blade obscurely trilobed to deeply trifid, the margins gene-

rally undulate, the central lobe usually longer than the lateral lobes, lip may be held horizontally with the blade pendent, or the whole structure may be pendent; anther more or less horizontal, 1–3 mm long, viscidia separate; rostellum equally trifid, erect, the lobes acute, 1–2 mm tall; stigma with the lateral lobes much larger than the odd lobe, horizontal, 2–3 mm wide and 1 mm tall.

Diagnostic features. Petal spatulate, claw linear, 5–35 mm long, blade obscure trilobed to deeply tripartite; leaves linear, flat, green at anthesis.

Two subspecies are recognized in this species. There are no absolute differentiating characters between the two postulated taxa, but the overlap in variation is minimal (see Fig. 5). The taxa are allopatric, with about 500 km between the two distribution areas. They may therefore be recognized as geographical subspecies.

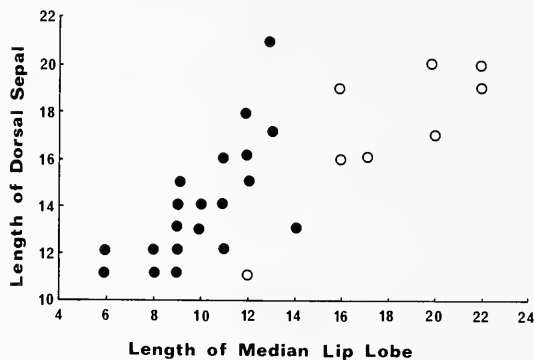


FIG. 5.—Variation in flower size (measured by the length of the dorsal sepal) and lip shape (measured by the length of the median lip lobe) in *H. spathulata*.

(a) subsp. *spathulata*

Orchis spathulata L. f., Suppl. Pl. 398 (1781). *Satyrion spathulatum* (L. f.) Thunb., Prod. 5 (1794). *Disa spathulata* (L. f.) Swartz in Vet. Acad. Handl. 21: 213 (1800); Lindl., Gen. Sp. Orch. 353 (1838); Kraenzl., Orch. Gen. Sp. 1: 794 (1900); Schltr. in Bot. Jb. 31: 283 (1901), pro parte. *Herschelia spathulata* (L. f.) Rolfe in Fl. Cap. 5, 3: 205 (1913). Type: Cape of Good Hope, Thunberg s.n. (LINN, holo.; UPSI; W.).

Disa propinqua Sond. in Linnaea 19: 95 (1847). Type: Cape Province, Clanwilliam Division, Brakfontein, Ecklon & Zeyher s.n. (S, holo.; K!; W!).

D. propinqua Sond. var. *trifida* Sond. in Linnaea 19: 96 (1847). Type: not seen.

D. atropurpurea Sond. in Linnaea 19: 96 (1847); Kraenzl., Orch. Gen. Sp. 1: 794 (1900). *D. spathulata* var. *atropurpurea* (Sond.) Schltr. Bot. Jb. 31: 284 (1901). *Herschelia atropurpurea* (Sond.) Rolfe in Fl. Cap. 5, 3: 205 (1913). Type: Cape Province, Tulbagh District, Tulbagh Waterfall, Ecklon & Zeyher s.n. (S, holo.; K!).

Icones: Curtis's bot Mag. t. 6891 (1886), as *Disa atropurpurea*; H. Bol., Icones Orch. Austro-Afr. 3: t. 53 (1913), as *D. spathulata*; 3: t. 54, as *D. spathulata* var. *atropurpurea*; Rice, Wild. Flow. Cape G. H. 163.2 (1950).

Central lobe of lip 5–14 mm long, inflorescence with 1–5 flowers (Fig. 6). Distributed in the western Cape Province from Caledon to Nieuwoudtville. Flowering time: September and October.

Widespread in the western Cape Province (Fig. 7) on both sandstone and shale, in a range of habitats, usually occurring in small populations.

CAPE.—3119 (Calvinia): in mountains near Twakfontein, Nieuwoudtville (–AC), *Leipoldt* 601 (BOL). 3218 (Clanwilliam): in sand near Swartboschkraal (–BC), Sept. 1894, *Schlechter* 5165

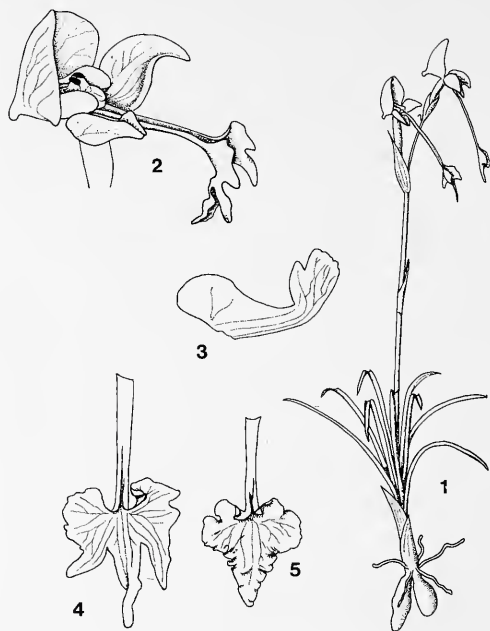


FIG. 6.—*Herschelia spathulata* subsp. *spathulata*. 1, habit, $\times 0.5$, from Linder 1244. 2, flower, $\times 1.5$, from Linder 1453. 3, petal, $\times 3$, from Linder 1453. 4, lip, $\times 1.5$, from Linder s.n. 5, lip, $\times 1.5$, from Linder 1245.

(BOL; P; PRE; W; Z). 3319 (Worcester): Tulbagh (–AC), Oct., *Pappe* s.n. (BOL; SAM). 3419 (Caledon): Boontjieskraal (–AA), Sept. 1977, Linder 1458, 1459 (BOL).

The altitude range of this species is from 150 to 1 000 m and the precipitation ranges from 200 to 800 mm p.a., mostly occurring in the winter months. The species has been recorded from both gravelly and deep alluvial sands derived from Table Mountain Sandstone, as well as clayey soils derived from Malmesbury shales. Populations growing on shales occurred most frequently on the cooler south-facing slopes, whereas those located on sandstone derived soils ranged from well-drained sites to the margins of temporary vleis.

The variation patterns in this subspecies are complex, with four characters varying extensively (flower size, lip lobe shape, flower colour and the three-dimensional position of the lateral sepals). The characters are to some extent correlated and a small-flowered form (probably *Disa atropurpurea*) and a large-flowered form may be recognized. The small-flowered form has dark red flowers, the lip lobe is more or less ovate and the lateral sepals appear to close at night, whereas the large-flowered form has pale lime or green or pale red flowers, the lip lobe is deeply three-lobed, and the lateral sepals are always spreading. Both forms may be found over the whole distribution range of the subspecies. However, a survey of the available herbarium material indicated that the variation range of each character is continuous, and the characters are not perfectly correlated. No formal taxa are therefore recognized.

The subspecies was studied in the field in several localities. Only at two localities, Wolseley and Caledon, did both forms occur together. At Wolseley (near Worcester) the small-flowered form occurred on a well-drained slope, whereas the large-flowered form occurred about 3 km distant on the margin of a temporary vlei (Linder 1244, 1245). At Caledon both forms occurred on the same slope, and the individuals of the two forms occurred intermixed. The

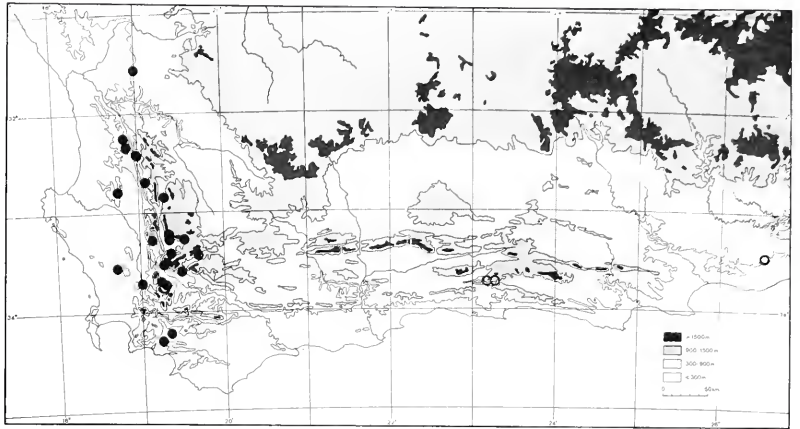


FIG. 7.—Distribution of *H. spatulata* subsp. *spatulata* (solid circles) and subsp. *tripartita* (open circles).

small-flowered form was much rarer than the large-flowered form. An analysis of this population for two characters (flower size and the lip shape) (Fig. 8) clearly shows a bimodal distribution, with a few rare intermediate forms.

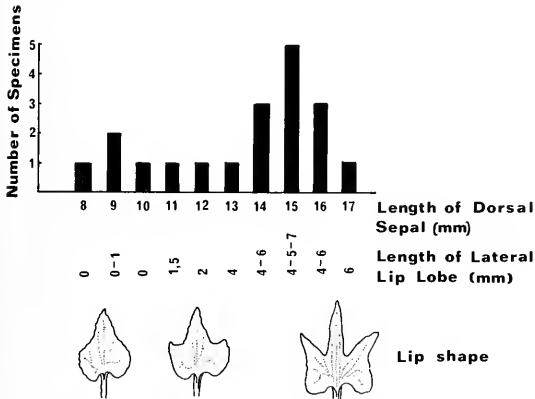


FIG. 8.—Variation in the lip shape, length of the lateral lip lobe and flower size in one population of *H. spatulata* subsp. *spatulata*.

The treatment here is provisional. A detailed study is required to elucidate the mechanism by which this complex polymorphism is maintained. Could this be a case of incipient sympatric speciation?

Sonder (1847) distinguished his *Disa propinqua* from *H. spatulata* by its generally more robust nature. I have studied the type specimen: it is not much different from the type of *H. spatulata* and is clearly included in the range of variation of the latter taxon. *Disa atropurpurea* was distinguished from its congeners by the shorter lip claw and the maroon colour of the flowers (Bolus, 1913; Rolfe, 1913). Lip claw length varies continuously in *H. spatulata* from shorter than that of the type of *D. atropurpurea* to 35 mm. Flower colour and the lip shape indicate, however, that it may well belong to the cryptic small-flowered form discussed above. It appears as if Hooker (1886) and subsequent botanists have misunderstood the complex nature of the so-called *H. atropurpurea*.

(b) subsp. *tripartita* (Lindl.) Linder, stat. et comb. nov.

Disa tripartita Lindl., Gen. Sp. Orch. 353 (1838); Kraenzl., Orch. Gen. Sp. 1: 797 (1900). Type: Eastern Cape Province, Albany, Geelhoutboom, Drège 3577a (K, holo.; P!; S!).

D. spatulata (L. f.) Swartz, Schltr. in Bot. Jb. 31: 284 (1901), pro parte.

Herschelia tripartita (Lindl.) Rolfe in Fl. Cap. 5, 3: 204 (1913).

Central lobe of the lip (12–) 16–22 mm long, inflorescence with 1–2 flowers. Recorded from the Uniondale area in the Langkloof.

Flowering time: October.

Distribution: Fig. 7.

CAPE.—3323 (Willowmore): Haarlem (–CB), Oct. 1930, Fourcade 4344 (BOL); Louterwater (–DC), Sept. 1969, Marsh 1408 (PRE).

This subspecies is rather local in the renosterbosveld near the summit of the Langkloof, near Uniondale. The rainfall in the area is about 600 mm p.a. which is distributed over the whole year.

The type locality for this subspecies is on the Bushmans River, near Grahamstown. This is about 250 km to the east of other known distribution records. It is difficult to decide whether Drège's locality is incorrect, or whether this species is more widely distributed than the present records indicate.

Ser. *Herschelia*

Lip sessile, narrowly elliptical to elliptical, margins crenulate, petals with apices expanded into flabellate structures.

Type species: *H. granifolia* (Spreng.) Dur. & Schinz.

Two closely related species are included in this series: *H. granifolia* and *H. purpurascens*. The former species is widespread from the Cape Peninsula to Port Elizabeth, and the latter is restricted to the southern Cape Peninsula and the coastal areas of the Caledon Division. The habitat differences between the two taxa are summarized in Table 3. Although populations of the two species occur within a few kilometres of each other, it is clear that the species occupy quite different habitats. These differences are maintained by the prevention of gene flow between the two species by allochronic flowering (Table 4). The earlier flowering of *H. purpurascens* might be the result of this species occupying a drier habitat but, as the flowering time remains the same under cultivation, it appears to be genetically fixed.

TABLE 3.—A comparison of the habitats of *H. graminifolia* and *H. purpurascens* in the western Cape

Environmental factor	<i>H. graminifolia</i>	<i>H. purpurascens</i>
Altitude	50 – 1 350 m	0 – 100 m
Rainfall annual*	1 500 – 2 500 mm	800 – 1 200 mm
Rainfall in January*	30 – 80 mm	15 – 25 mm
Fog in summer	Frequent	Never
Snow in winter	Occasional	Never

*Measured at Simonstown and Kleinmond for *H. purpurascens*, and at Table Mountain (Maclears Beacon) and Steenbras Dam (Caledon Division) for *H. graminifolia*.

TABLE 4.—Flowering times of *H. graminifolia* and *H. purpurascens*

Month	<i>H. graminifolia</i>	<i>H. purpurascens</i>
October	26%	—
November	70%	—
December	4%	12%
January	—	24%
February	—	41%
March	—	22%
Number of collections	27	49

5. *Herschelia graminifolia* (Spreng.) Dur. & Schinz, Consp. Fl. Afr. 5: 111 (1894); Kraenzl., Orch. Gen. Sp. 1: 802 (1900).

Disa graminifolia Ker-Gawl. ex Spreng. in Linn. Syst. Veg. 3: 699 (1828); Schltr. in Bot. Jb. 31: 290 (1901). Type: Cape of Good Hope, Masson s.n. (BM, holo.).

Herschelia coelestis Lindl., Gen. Sp. Orch. 363 (1838); Rolfe in Fl. Cap. 5.3: 201 (1913). Type: Cape of Good Hope, Burchell 7801 (K, holo.).

Icones: Ker-Gawler in Q. Jl Sci. Arts t. 1, fig. 2 (1819); H.Bol. Icones Orch. Austro-Afr. 1: t. 37 (1893); Rice, Wild Flow. Cape G. H. 167.2 (1950); Flower Pl. Afr. 30: t. 1172 (1955).

Plants 500–1 000 mm tall; the base of the stem often with a sheath of old leaf fibres; radical leaves usually 5, 200–500 mm long and up to 5 mm wide, frequently rolled acute, semi-erect; cauline leaves lax, 6–9, 20–40 mm long, acuminate, closely sheathing; inflorescence lax, 40–120 mm long and with 2–6 flowers; bracts about 2/3 as long as the ovaries, dry, broadly ovate, acuminate to setaceous; ovaries 15–25 mm long, straight or slightly curved. Flowers blue to

violet-purple, apices of the petals green and the lip more purple than the sepals; dorsal sepal erect, galea obtuse, 15–20 mm tall and 5–10 mm deep; spur from the base of the galea, usually straight, 2–4 mm long, clavate, rounded rarely cylindrical and obtuse; lateral sepals narrowly oblong to oblong, obtuse, apiculate, patent, 13–18 mm long and 6–10 mm wide; petals with the basal anticous lobe orbicular to rarely oblong, margins usually entire, 3–4 mm in diameter, limb of the petal lorate, 11–16 mm long, geniculately upcurved through 90° about 2/3 down the length, the apex expanded into a flabellate structure with entire or dentate margins and a diameter of 4–6 mm, twisted to stand erect behind the anther; lip narrowly elliptical to elliptical, margins usually denticulate and down-curved, obtuse, patent, 11–16 mm long; anther c. 5 mm long, viscidia separate or fused; rostellum with three equal lanceolate lobes; stigma flat, unequally three-lobed. Fig. 10.

Diagnostic features. Lip entire, spur 2–4 mm long, clavate, lip flat or the margins somewhat down-curved.

Flowering time: (December–) January to March.

Widespread and local along the coastal mountains from the Cape Peninsula to Port Elizabeth on soils derived from Table Mountain Sandstone, usually in well-drained stony habitats (Fig. 9).

CAPE.—3319 (Worcester): Slanghoek Ridge Peak, 1 350 m (–CA), March 1952, *Esterhuysen* 19990 (BOL). 3318 (Cape Town): Table Mountain, 750 m (–CD), February 1884, *MacOwan & Bolus* 167 (BOL; BM; K; P; SAM; W; ZT). 3320 (Montague): Langeberg near Swellendam (–CD), January 1893, *Schlechter* 2061 (BOL; Z). 3323 (Willowmore): Louterwater (–DC), January 1941, *Compton* 10499 (NBG).

Although this species is widespread, there appear to be sizeable gaps in the distribution range. This could reflect the lack of botanical exploration of the Langerberg. Distinct populations may be readily recognized, although individuals are quite far apart. There appears to be rather little variation among the populations. Occasional, presumably recessive, white-flowered plants have been found.

The altitude range of the species is from 300 m to 1 500 m, and the majority of collections are from areas receiving in rainfall, an excess of 1 000 mm p.a., usually with no long dry season.

The species was first referred to in the literature by Ker-Gawler, who published a plate of it in 1819. The

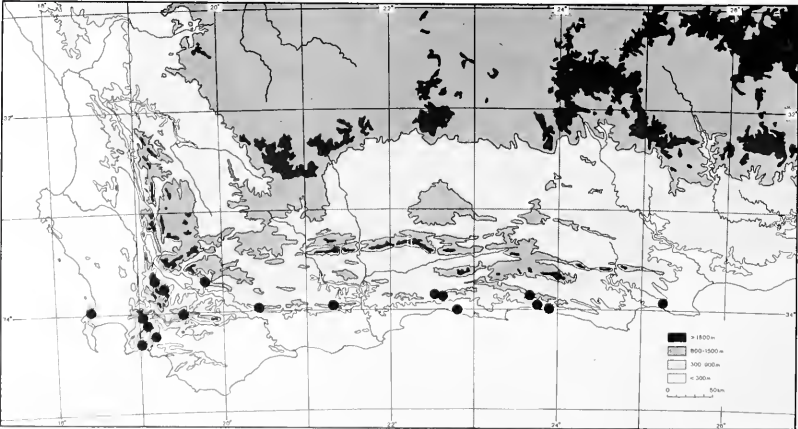


FIG. 9.—Distribution of *Herschelia graminifolia*.

plate was prepared by a 'Dutch' soldier, 'an artist of great skill as a designer of the objects of natural history', whom Francis Masson met at the Cape. Although Ker-Gawler annotated the plate as '*Disa graminifolia*', he provided neither a description nor a diagnosis. According to Article 32.1 (c) of the I.C.B.N. (1978), the name has to be regarded as a *nomen nudum*. In 1828 Sprengler lists *Disa graminifolia*, providing it with a Latin description and refers to the Masson collection. Sprengler therefore validly published the name.

Lindley (1838) refers the name *Disa graminifolia* to the synonymy of his *Herschelia coelestis*. Rolfe (1913), following the Kew Rule, upheld *Herschelia coelestis* in preference to *H. graminifolia*. *H. graminifolia*, as the oldest available name, has to be upheld as correct.

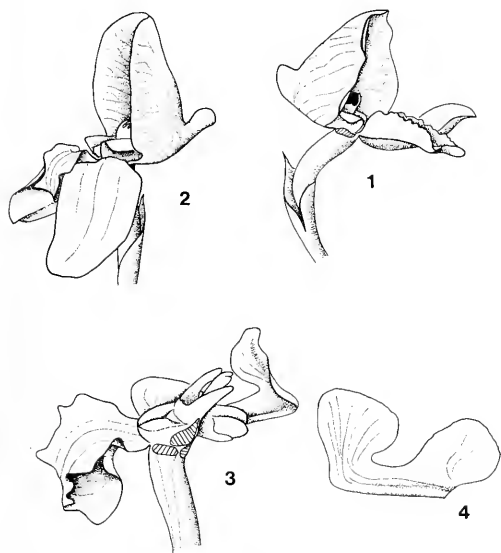


FIG. 10.—*Herschelia purpurascens* (1) and *H. graminifolia* (2–4). 1, flower of *H. purpurascens* with one lateral sepal removed, $\times 1.5$, from Linder 759. 2, flower of *H. graminifolia*, $\times 1.5$. 3, lip, column and petal of *H. graminifolia*, $\times 1.5$. 4, petal, $\times 3$. (2–4 from Linder 1763.)

6. *Herschelia purpurascens* (*H. Bol.*) Kraenzl., *Orch. Gen. Sp.* 1: 803 (1900); Rolfe in *Fl. Cap.* 5: 3: 200 (1913). Type: Cape Province, Cape Peninsula, Muizenberg Mountain, *Bolus* 4893 (BOL, holo.!: K!).

Disa purpurascens H. Bol. in *J. Linn. Soc., Bot.* 20: 482 (1884); Schltr. in *Bot. Jb.* 31: 291 (1901).

Icones: H. Bol., *Icones Orch. Austro-Afr.* 1: t. 86 (1896); Rice, *Wild Flow. Cape G. H.* 146.3 (1950).

Plants 250–500 mm tall; tubers c. 30 mm long and 10 mm in diameter; base of the stem frequently with a sheath of old leaf fibres; radical leaves about 10, from half as long as the stem to as long, up to 1 mm wide, rigid and erect, the midrib sclerenchymatous and prominent; cauline leaves completely sheathing, 5–7, acuminate, dry, 20–40 mm long, grading apically into the floral bracts; inflorescence lax, up to 15 mm long and with 1–2–7 flowers; bracts $\frac{1}{2}$ to $\frac{2}{3}$ as long as the ovaries broadly ovate, acuminate to setaceous, dry; ovaries 15–20 mm long, straight or slightly curved. *Flowers* blue, the lip more purplish than the sepals, the rear lobes of the petals yellow or

green; dorsal sepal erect, galea subacuminate, 15–25 mm tall and 10–15 mm deep, ovate; spur from the base of the galea, horizontal or slightly curved upwards, conical obtuse, 1–4 mm long; lateral sepals oblong, acute, patent, 15–18 mm long; petals with the basal anticus lobe oblong to semicircular, 3–4 mm in diameter, the margin entire or crenulate, the limb of the petal lorate, 8–10 mm long, falcately curved upwards inside the galea, the apex expanded into a 4–5 mm wide fan with a crenulate margin; lip broadly ovate, obtuse, with a short limb, margins crisped and curved upwards, 12–18 mm long; anther horizontal, 3 mm long, with two viscidia that may be partially fused; rostellum equally 3-lobed, 2.5 mm tall; stigma sub-equally 3-lobed, horizontal, 4 mm in diameter. Fig. 10

Diagnostic features. Lip margin undulate, curved upwards; spur conical, tapering to an obtuse point, lateral sepals 15–18 mm long.

Flowering time: October and November.

Local near the coast at low altitudes in the southern Cape Peninsula and the Caledon Division, (Fig. 11), growing in well-drained localities.

CAPE.—3418 (Simonstown): Simonstown (–AB), November 1892, *Fair* in BOL 7992 (BOL); Cape Point (–AD), November 1947, *Compton* 20236 (NBG). 3419 (Caledon): Betty's Bay (–BD), November 1977, *Linder* 759 (BOL).

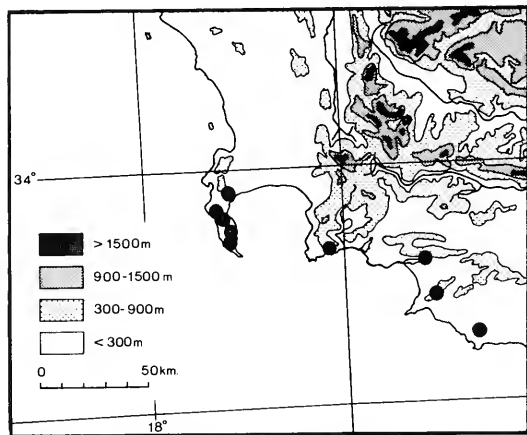


FIG. 11.—Distribution of *Herschelia purpurascens*.

This species has a rather restricted distribution along the coast line along the southern Cape Peninsula and between Cape Hangklip and Cape Agulhas. The altitude range of the species is from sea level to about 100 m. The summers tend to be dry, with only occasional rain. The rainfall in this region varies from 800 to 1 200 mm p.a. Although this species is not common, populations are not as scattered as in *H. graminifolia*. There is not much variation in the species, but occasional plants with white flowers have been recorded (possibly the recessive condition).

H. purpurascens is very close to *H. graminifolia*, from which it may be distinguished by the conical spur, the upcurved lip margins and the much earlier flowering time.

Ser. *Lacerae* Linder, ser. nov., labello crenato vel lacero, petalis bidentatis laceris vel acutis. dignoscenda.

Type species: *H. lugens* (H. Bol.) Kraenzl.

Lip sessile or spatulate, the apical blade generally lacerate, rarely entire, petals bidentate, lacerate or acute.

This series contains nine species, all closely related. If a species such as *H. forcipata* or *H. hians* is selected as the starting point, several clear lines of development of the petal and lip structures may be detected. The lines all lead from an entire to a bearded lip, and from a simple acute petal to a lacerate or bifid petal apex. These postulated relationships are graphically shown in Fig. 12.

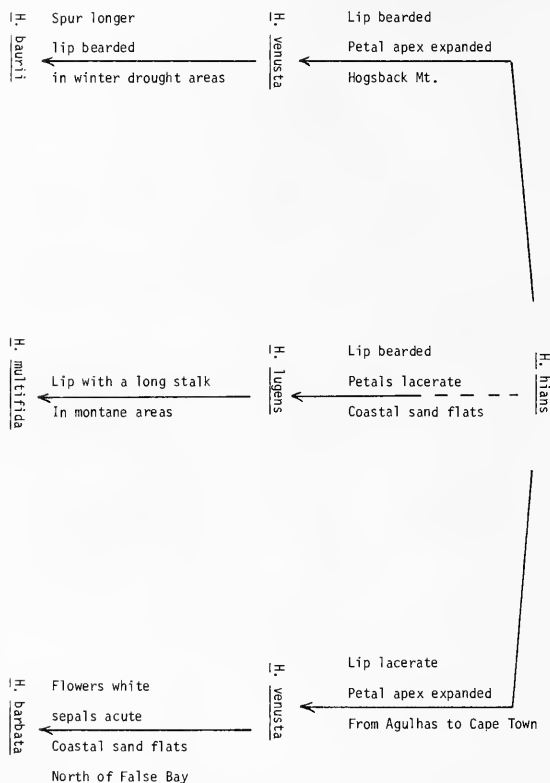


FIG. 12.—Relationships and putative evolution of *Herschelia* ser. *Lacerae*.

The relationships of *H. hians*, *H. venusta* and *H. forcipata* are not clear, and Hall (1973b) included the former two in the same species. *H. hians* is well established in the southern Cape Province, and the majority of the collections do not show much variation; however, in some populations the lip margins may vary from almost entire to deeply lacerate, as opposed to the normal crenulate condition. *H. forcipata* is clearly very closely related to *H. hians*, but differs in the shallowly bidentate spur and the long floral bracts. It is quite possible that further fieldwork may show that these forms also lie within the range of variation of *H. hians*. The position of *H. venusta* is somewhat clearer. The lip is irregularly lacerated, and the petal somewhat expanded towards the apex (Fig. 14). The distribution of this species is puzzling, with records from the Caledon and Cape Peninsula Divisions, and the Hogsback Mountains near King William's Town. Either the species has had a polytopic origin, or it is merely an extreme form of *H. hians*.

From this postulated basal group three lines of development may be suggested:

(a) to *H. barbata*. This species is quite closely related to *H. venusta*, especially to the forms of that species occurring on the Cape Peninsula. Compared to *H. venusta*, *H. barbata* shows many of the characteristics of a more recently derived species: an almost unique flower colour (white) in the genus, an inflorescence with few large flowers (cf. Linder, 1981), and a small, probably neo-endemic distribution range. Until a few decades ago, the two species overlapped on the Cape Peninsula, but with the extinction of the Cape Peninsula populations of *H. barbata*, the interaction between the two taxa in the overlap zone can no longer be investigated.

(b) to *H. multifida*. *H. lugens* and *H. multifida* are closely related, sharing several peculiar characters: lacerate petals, green bearded lips, a shortish conical spur. Morphologically they can only be separated by the length of the lip stalk. Within *H. multifida* there is extensive variation in the length of the lip stalk, but the great majority of the populations possess a lip stalk, longer than 20 mm, whereas only a few populations on the fringes of the distribution range of the species have shorter lip stalks. One collection from the Cape flats, *Schelte* 6313, possesses some flowers typical of *H. lugens* (Fig. 14); others have a lip stalk up to 10 mm long, approaching the type collection of *H. multifida*. With the exception of the populations around Grahamstown, *H. lugens* occurs on coastal sandy flats, and *H. multifida* occurs in the montane areas. *H. lugens* occasionally grows mixed with *H. hians* (Hall 664), but the relationship to this species is not clear.

(c) to *H. baurii*. *H. baurii* is linked to *H. hians* via *H. venusta*, and again the differences between the species are not very clearcut. Morphologically the South African populations of *H. baurii* may be separated from *H. venusta* by the longer spur and the more deeply dissected lip, whereas the northern populations of *H. baurii* are distinguished by the equally bidentate petals. Ecologically, *H. baurii* is the tropical extension of a Cape genus, and it occurs in areas of winter drought. *H. baurii* shows extensive geographical variation, but in only two places does this result in speciation: in the Chimanimani Mountains (*H. chimanimaniensis*) and the Nyika Plateau (*H. praecox*). Detailed analysis of populations may result in the recognition of geographical subspecies within the species, but at present the data for this are inadequate.

7. *Herschelia barbata* (L. f.) H. Bol. in J. Linn. Soc., Bot. 19: 236 (1882); Kraenzl. in Orch. Gen. Sp. 1: 804 (1900); Rolfe in Fl. Cap. 5, 3: 201 (1913). Type: Cape of Good Hope, *Sparrman* s.n. (LINN, holo.!, S!).

Orchis barbata L. f., Suppl. Pl. 399 (1781). *Satyrium barbatum* (L. f.) Thunb., Prod. 5 (1794). *Disa barbata* (L. f.) Swartz in Vet. Acad. Handl. 21: 212 (1800); Lindl., Gen. Sp. Orch. 354 (1838); Schltr. in Bot. Jb. 31: 286 (1901).

Icones: H. Bol. Icones Orch. Austro-Afr. 3: t. 51 (1913), as *Disa barbata*; Mason, Western Cape Sandveld flowers, Pl. 34.2 (1972).

Plants 250–500 mm tall, the base of the stem often with a sheath of fibrous leaf remains; tubers oval to cylindrical, 20–40 mm long; radical leaves often reaching the base of the inflorescence but never overtopping the flowers, c. 1 mm wide, the base expanded to clasp the stem, conduplicate, 4–7, sclerenchymatous; cauline leaves completely sheathing, lanceolate,

acuminate, 20–40 mm long, dry, grading into the floral bracts; inflorescence lax, about 60 mm long and with 2–6 flowers; bracts dry, half as long to as long as the ovary, lanceolate, acuminate; ovaries 15–20 mm long, straight or slightly curved. *Flowers* white to very pale blue, veins and lip more or less blue, spur often green, no scent detected; dorsal sepal angled forwards, galea acuminate, 15–25 mm long, 13–18 mm wide and 8–12 mm deep, ovate; spur conical, not clearly distinct from the galea, usually obtuse to shallowly bifid, rarely acute, straight or rarely upcurved, 1–5 mm long; lateral sepals patent, narrowly oblong, acute, suboblique, 15–25 mm long; petals with the basal anticus lobe oblong, c. 2 mm in diameter, flanking the stigma, usually decurrent with the rest of the petal, the limb linear, straight or subfalcate, 5–6 mm long, apex obtriangular, incised to bifid, 3–4 mm long and c. 3 mm wide; lip horizontal at the base and soon decurved, ovate, deeply lacerate, c. 15 mm long, the entire central part lanceolate, c. 3 mm wide; anther 3 mm long with 2 distinct viscidia, often only partially separated, elliptical to ovate, taller than wide; rostellum almost equally trilobed, lobes awn-shaped, 1.5 mm long, erect; stigma unequally tripulvinate, the odd lobe much smaller than the lateral lobes, horizontal, fused to the base of the rostellum. Fig. 14.

Diagnostic features. Lip deeply lacerated or bearded; flowers white to pale blue with pale blue veins; inflor-

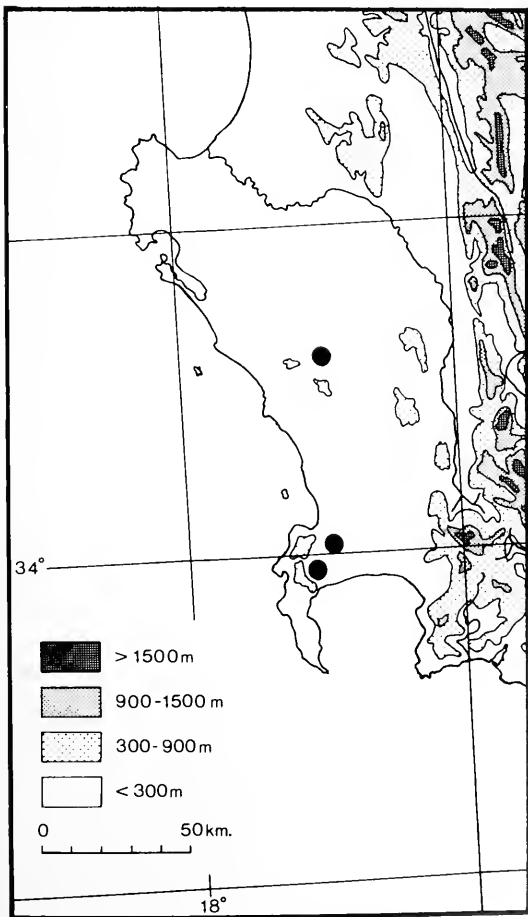


FIG. 13.—Distribution of *Herschelia barbata*.

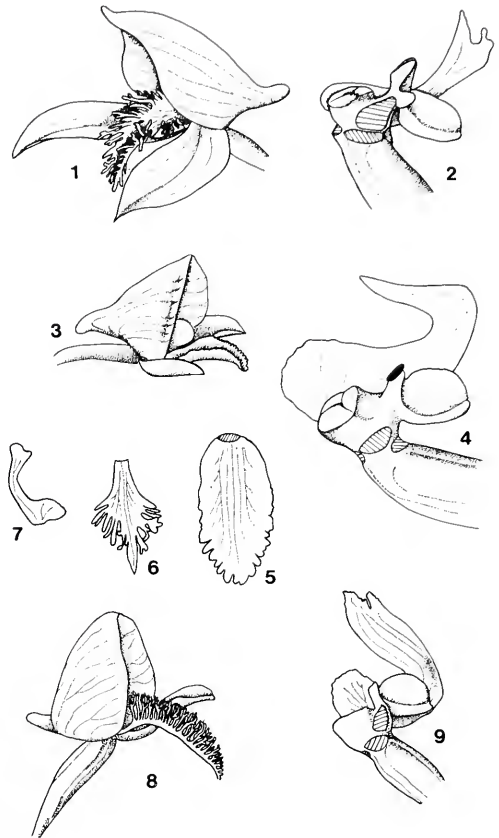


FIG. 14.—*Herschelia barbata* (from Linder 1806): 1, flower, $\times 1.5$; 2, column and petal, $\times 5$. *Herschelia hians* (from Linder 1731): 3, flower, $\times 1.5$; 4, column and petal, $\times 6$; 5, lip, $\times 3$. *Herschelia venusta* (from Bolus 17494): 6, lip, $\times 3$; 7, petal, $\times 3$. *Herschelia lugens*: 8, flower with one lateral sepal removed, $\times 1.5$, from Schelpe 6313; 9, column and petal, $\times 3$, from Jacot-Guillarmod s.n.

escence with 2–6 flowers; dorsal sepal acuminate, 15–25 mm long.

Flowering time: October and November.

Very local and rare in damp sandy localities on the Cape Flats and sandy coastal flats to the north of the Cape Peninsula, mostly extinct (Fig. 13).

CAPE.—3318 (Cape Town): Mamre Road, 150 mm (–BC), November 1978, Linder 1806 (BOL); sand dunes on the Cape Peninsula, 30 m, (–CD), October 1883, MacOwan & Bolus 166 (BM; BOL; K; P; W; ZT).

This species is at present known from a single locality near Darling. Formerly it appears to have been relatively common on the Cape Flats, where it was frequently collected: the populations in these localities now all appear to be extinct. It occurs in damp to wet areas on Recent Sand, near sea level. The rainfall in these areas occurs almost wholly in the winter months, and is approximately 400–600 mm p.a.

This species is closely related to *H. venusta*, from which it may be distinguished by the more acuminate sepals and the white flowers. Formerly the two taxa overlapped on the Cape Peninsula, and both were recorded from the Kenilworth Race Course. Due to human activities during the last decades, the taxa are now allopatric.

8. *Herschelia venusta* (*H. Bol.*) Kraenzl., Orch. Gen. Sp. 1: 805 (1900); Rolfe in Fl. Cap. 5,3: 202 (1913), excl. syn. Type: Cape Province, Cape Flats, *Bolus* 4556 (BOL, lecto.!: K!; PRE!).

Disa venusta H. Bol. in J. Linn. Soc., Bot. 20: 482 (1884).

D. lacera Swartz, Schltr. in Bot. Jb. 31: 287 (1901), pro parte.

Icones: H. Bol., Icones Orch. Austro-Afr. 3: t. 52 (1913), as *D. lacera*; Flower. Pl. Afr. 6: t. 234 (1926), as *D. lacera*.

Plants 300–600 mm tall; tubers up to 40 mm long; base of the stems often with a sheath of old leaf fibres; radical leaves 6–12, reaching to the base of the inflorescence or shorter, less than 2 mm wide, sclerophyllous with the veins prominent, rigid-erect; cauline leaves lax, acuminate, 15–40 mm long, brown; inflorescence lax with 2–5–12 flowers; bracts dry, as long as the ovary or half as long as the ovary, ovate, acuminate; ovaries 15–20 mm long, straight or curved. Flowers blue; dorsal sepal erect, acuminate, galea 10–18 mm tall and 4–8 mm deep; spur horizontal from the base of the galea, conical, acute, 1.5–3 mm long; lateral sepals patent, oblong to narrowly oblong, obtuse to acute, 12–16 mm long; petals with small basal anticus lobes, oblong, 1.5 mm long, the limb linear, falcate, 6 mm long, apically expanded to form a fan up to 3 mm wide or unequally and often obliquely bilobed; lip more or less ovate in outline, variably lacerate, shorter than the lateral sepals, curved downwards, 7–12 mm long; anther horizontal, 2 mm long, possibly with the two viscidia fused; rostellum with 3 equal narrowly lanceolate lobes, 1 mm tall; stigma unequally 3-lobed, 2 mm wide and 1 mm tall, horizontal. Fig. 14.

Diagnostic features. Flowers with the lateral sepals 12–16 mm long; spur 1.5–3 mm long; lip variably lacerate; petals with the basal anticus lobe less than 2 mm long, the limb linear, falcate with an expanded apex or strongly unequally bifid.

Flowering time: October—January.

Local along the coast of the Cape Peninsula and the Caledon Divisions, growing probably in sandy or damp localities, rare in the Hogsback Mountains near King William's Town (Fig. 15).

CAPE.—318 (Cape Town): Kenilworth, 30 m (–CD), *Bolus* s.n. (BOL). 3419 (Caledon): Hermanus Flower Show exhibit (–AD), *Specimen in BOL* 17494 (BOL); Vogelgat (–AD), *Schlechter* 9544 (BOL; BR; PRE). 3227 (Stutterheim): Hogsback Mountain (–CA), *Rattray in BOL* 15770 (BOL).

I have not seen this species in the wild. It occurs from the Cape Peninsula to Hermanus on the Caledon Coast, and near King William's Town. Collector's notes indicate damp habitats, generally under sandy conditions. The taxon is possibly extinct on the Cape Peninsula, where it has only been recorded

from the Kenilworth Race Course and from Steenberg. However, it appears to be locally common in the Betty's Bay and Hermanus areas, only flowering after fire.

There are two collections from the Hogsback Mountains near King William's Town which have to be referred to this species. However, there are numerous slight differences, difficult to quantify, which raise the possibility that the Hogsback population may have been derived independently from *H. hians*.

This species has previously been included in *H. hians*, as the lip shape was used as the sole differentiating character. Although the lip shape in *H. venusta* is somewhat different from that in *H. hians*, the extensive variation that may be found in a single population in both species is convincing evidence that this character may not be sufficiently reliable for specific delimitation. *H. venusta* may also be differentiated from *H. hians* by the shorter spur, the much more slender petal with a more slender limb, a smaller basal anticus lobe and the enlarged bifid apex, and by the shallower galea. On this evidence, it is here regarded as distinct.

Bolus (1884) cited two syntypes. *Bolus* 4566 occurs in three herbaria, and the material is in better condition, than *Harvey* 140. The former was therefore selected as lectotype.

9. *Herschelia lugens* (*H. Bol.*) Kraenzl., Orch. Gen. Sp. 1: 806 (1900); Rolfe in Fl. Cap. 5,3: 203 (1913). Types: Cape Province, near Cape Town, *Bolus* 3810 (BOL, lecto.!: K!); near Kuils River, *Pappe* 377 (BOL!; SAM!), *Pappe* 39 (BOL!; K!; SAM!), *Ecklon* 1566 (G!; S!; SAM!; W!).

Icones: H. Bol., Icones Orch. Austro-Afr. 2: t. 76 (1911); Curtis's bot. Mag. t. 8415 (1912); Rice, Wild Flow. Cape G. H. 148.2 (1950).

Plants 450–1000 mm tall; tubers 2–3, c. 50 mm long and 20 mm wide; base of the stem often with a sheath of old leaf fibres; radical leaves 8–15, from ½ to ⅔ as long as the shoot, never overtopping the lowest flower in the spike, c. 2 mm wide, rigid erect, the veins sclerified and prominent; cauline leaves lax, acuminate, 60–20 mm long with the longest at the base of the stem, dry, grading into the floral bracts; inflorescence lax, 70–150–400 mm long and with 5–10–25 flowers; bracts about half as long as the ovaries broadly ovate, acuminate to setaceous, dry; ovaries slender, slightly curved, 15–25 mm long. Flowers with a cream-green galea, mauve lateral sepals, a green to grey-green lip and white petals, but with some variation in the colour rarely almost black; dorsal sepal erect, galea obtuse, 12–16 mm tall and about 10 mm deep, narrowly ovate; spur from the base of the galea, generally slender, cylindrical, straight or curved upwards, 1–5 mm long, sometimes conical; lateral sepals patent, narrowly oblong, obtuse or acute, 8–13 mm long, subconduplicate in the apical half; petals with the basal anticus lobe oblong, c. 4 mm long, parallel to the stigma; limb linear, 10–15 mm long, with a geniculate bend through c. 90° near the middle, the distal half of the petal varying from obliquely obtriangulate to lorate, acute or deeply lacerate; lip ovate, c. 13–19 mm long, deeply dissected and beard-like, horizontal at the base but soon decurved, longer than the lateral sepals; anther horizontal or semi-pendent, 3 mm long, viscidia separate; rostellum equally 3-lobed, c. 1.5 mm tall; stigma unequally 3-lobed with the odd lobe smaller than the lateral lobes, horizontal, 3 mm in diameter. Fig. 14.

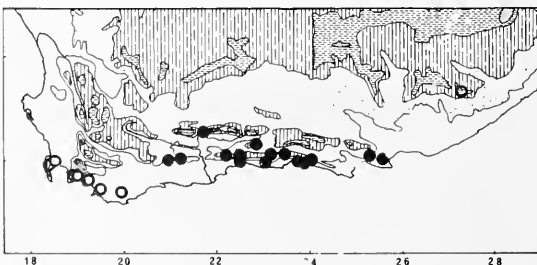


FIG. 15.—Distribution of *Herschelia venusta* (open circles) and *H. hians* (closed circles).

Diagnostic features. Flowers medium-sized, lateral sepals 8–13 mm long; lip bearded, longer than the lateral sepals, greenish or almost black.

Flowering time: October to November (–March).

This species occurs locally along the coastal flats between the Cape Peninsula and Port Elizabeth, usually in sandy well-drained conditions, and around Grahamstown in macchia on sandstone derived soils (Fig. 16).

(a) var. *lugens*

Disa lugens H. Bol. in J. Linn. Soc. 20: 483 (1884); Schltr. in Bot. Jb. 31: 288 (1901).

Flowers cream-green, lip usually much longer than the lateral sepals, widespread from the Cape Peninsula to Grahamstown.

CAPE.—3318 (Cape Town): sand dunes near Cape Town, 30 m (–CD), Nov. 1886, *MacOwan & Bolus* 494 (BOL; P; Z; ZT). 3421 (Riversdale): Yzervarkfontein (–BC), May 1913, *Muir* 908 (BOL; PRE). 3325 (Port Elizabeth): marshy flats near Van Staadens Railway Station, 300 m (–CC), Oct. 1958, *Hall* 664 (BOL). 3326 (Grahamstown): mountains near Grahamstown (–BC), *MacOwan* 700 (GRA; SAM).

This variety has a wide distribution, occurring rather locally on the coastal flats. The only inland locality is in macchia on the hills surrounding Grahamstown. In most localities and all localities south-west of Knysna, it occurs on deep sand, and usually grows inside restioid tussocks. A population studied near Grahamstown occurred on soils derived from quartzite. The majority of the populations occur in well-drained conditions, under a rainfall regime that varies from 500 to 1 000 mm p.a., in some areas evenly distributed over the whole year, and in others with a period of summer drought.

The association between plants of this species and restioid tussocks might be a result of predation, as plants under cultivation do not require restioid tussocks for normal growth.

This variety is becoming rare in the western Cape, owing to the spread of urban development in the coastal areas, and the spread of alien vegetation into the remaining habitats. It may already be extinct on the Cape Flats.

It was for some time confused with *Herschelia barbata*, because of the superficial similarity of the two taxa, especially when the plants are dried. Bolus (1884) cited several syntypes in his protologue, indicating that the material was known for some time without being recognized.

(b) var. *nigrescens* Linder, var. nov., a var. *lugenti* floribus nigrescentibus differt.

Flowers purplish black, recorded only from the coast at Cape St Francis, near Humansdorp.

TYPE.—Cape, 3424 (Humansdorp): near Oyster Bay in the vicinity of White Point (–BA), *Muller* s.n. (NBG, holo.!).

This almost black variety of *H. lugens* was only discovered in 1979 in the Humansdorp area, and as yet not much information is available about it. It appears to grow in the vicinity of the common *H. lugens* var. *lugens*, but may be distinguished by the almost black flowers, which also appear to be somewhat larger than is common for the typical variety. It is desirable to recognize this form formally, to prevent any confusion should the taxon be introduced into cultivation.

Information on the genetic status of the variety would doubtlessly give greater certainty about the rank of this taxon.

The two varieties grow sympatrically. Leaves and underground parts of the new variety were not seen.

10. *Herschelia multifida* (Lindl.) Rolfe in Fl. Cap. 5, 3: 206 (1913). Type: Cape Province, Clanwilliam District, Blouberg, *Drège* 3577b (K, holo.).

Disa multifida Lindl., Gen. Sp. Orch. 353 (1838); Schltr. in Bot. Jb. 31: 285 (1901).

D. charpentieriana Reichb. f. in Linnaea 20: 668 (1847); Schltr. in Bot. Jb. 31: 285 (1901). *Herschelia charpentieriana* (Reichb. f.) Kraenzl., Orch. Gen. Sp. 1: 807 (1900); Rolfe in Fl. Cap. 5, 3: 206 (1913); Hall in Flower. Pl. Afr. 42: t. 1673 (1973). Type: Cape of Good Hope, *Gueinzius* s.n. (W, holo.!).

D. macroglottis Sond. ex Drège in Linnaea 20: 219 (1847), nom. nud.

Icones: H. Bol., Icones Orch. Austro-Afr. 2: t. 77 (1911), as *Disa charpentieriana*; Rice, Wild Flow. Cape G. H. 1771 (1950), as *Herschelia charpentieriana*; Flower. Pl. Afr. 42: t. 1673 (1973), as *H. charpentieriana*.

Plants 400–600 mm tall; tubers up to 40 mm long; base of the stem often with a sheath of old leaf fibres; radical leaves 10–20, usually about half as long as the stem and rarely reaching to the base of the inflorescence, c. 1 mm wide, rigid with sclerenchymatous veins; cauline leaves completely sheathing, 20–50 mm long, lanceolate, acuminate, lax, grading into the floral bracts; inflorescence lax, 40–100 mm long and with 3–8 flowers; bracts

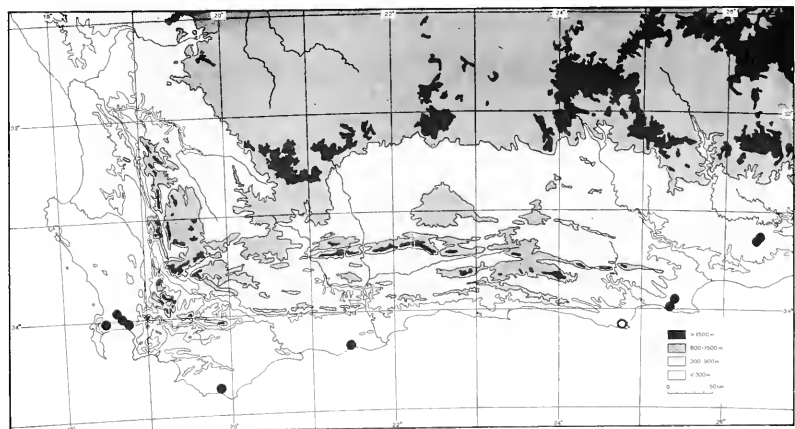


FIG. 16.—Distribution of *Herschelia lugens* var. *lugens* (closed circles) and var. *nigrescens* (open circle).

usually $\frac{3}{4}$ as long as the ovaries, broadly ovate, very acuminate to setaceous, dry; ovaries 15–20 mm long; straight or slightly curved. *Flowers* blue; with a green lip, often with greenish veins and a brownish spur; dorsal sepal erect, galea ovate, acuminate, 10–20 mm tall and c. 6 mm deep; spur conical, subacute, rarely cylindrical, obtuse or almost absent, generally curved downwards, 1–4–6 mm long; lateral sepals patent, lanceolate to narrowly ovate, acute, 10–15 mm long, the apical halves deeply concave; petals with the basal anticous lobe oblong, 3–4 mm long, the margins entire or crenulate, rarely decurrent with the limb, the limb falcate or rarely geniculate, linear, 7–10 mm long, the apex acute or narrowly obtriangular, occasionally lacerate; lip with a linear (10–) 30–65–100 mm long limb, the blade narrowly ovate, deeply lacerate; anther 3–4 mm long, viscidia narrowly ovate, c. 1 mm long; rostellum equally 3-lobed, lobes lanceolate, 1 mm long; stigma with the lateral lobes better developed than the odd lobe, on a 1 mm tall pedicel, 3.5 mm in diameter. Fig. 17.

Diagnostic features. Lip dissected, with a claw at least twice as long as the dissected blade and usually much longer.

Flowering time: November and December.

Herschelia multifida is a very distinct species that may always be recognized by its peculiar lip with a

long claw. It is rather widespread in the mountains of the Cape Floral Region, from Prince Albert in the south-east to the Vanrhynsdorp Bokkeveld in the north-west (Fig. 18).

CAPE.—3219 (Wuppertal): Cedarberg, Nov. 1913, *Pattison in BOL 14455* (BOL). 3319 (Worcester): Agterwittenberg Vlakke (—AA), Nov. 1967, *Powrie 168* (BOL); Darling Bridge (—CA), Nov. 1940, *Esterhuysen 3802* (BOL). 3419 (Caledon): base of mountains at Highlands Forest, Elgin (—AA), Nov. 1965, *Oliver in STE 29974* (PRE; STE). 3322 (Oudtshoorn): Swartberg Pass, slopes of Krevasberg, 1 200 m (—AC), Dec. 1942, *Stokoe 8679* (BOL).

This species occurs on slightly damp mountain sides: 'swampy slope' (Esterhuysen 20907) on the Rooodeberg near Ceres; well-drained soil near a stream on the Piketberg (*Linder 1642*), a slight seepage on a mountain side in the Skurfteberge near Ceres (*Linder 1656*) and a dry, well-drained stony mountain side, in the mist belt, on the Swartberg at Prince Albert (*Linder 1743*). Many of the populations receive snow almost every winter. Rainfall is also concentrated in the winter months, and is about 1 000 mm p.a. The altitude range of the species is from 300 to 1 500 m.

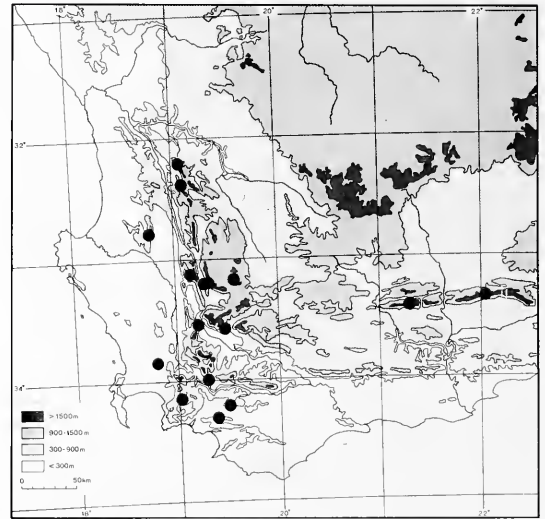


FIG. 18.—Distribution of *Herschelia multifida*.

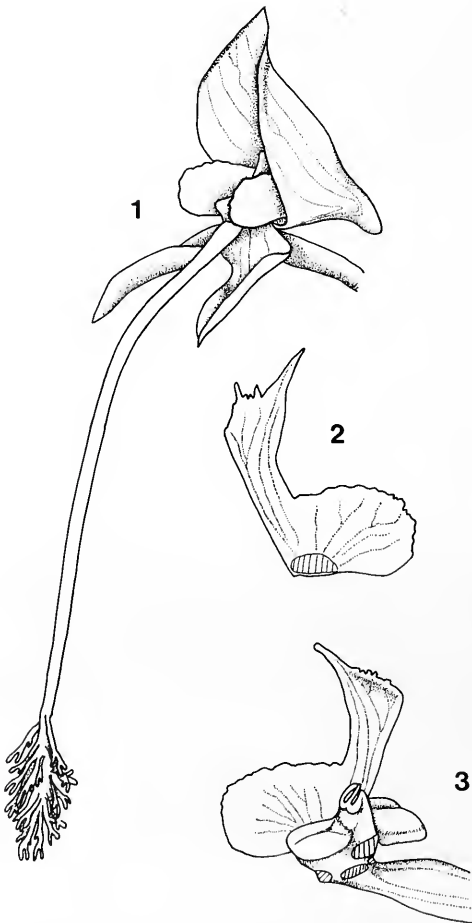


FIG. 17.—*Herschelia multifida*, from *Linder 1642*. 1, flower, $\times 1.5$. 2, petal, $\times 3$. 3, column, $\times 3$.

There is considerable variation in the lip length in this species: this is the basis on which *H. charpentieriana* and *H. multifida* had been separated (Schlechter, 1901; Rolfe, 1913). An analysis of the distribution of the short-spurred forms indicated that these collections all exist at the margin of the distribution area of the species as defined here, i.e. on the Swartberg above Prince Albert and in the Cedarberg and northwards to the Vanrhynsdorp Bokkeveld. It is suggested that the short-spurred form is a variation that occurs in the marginal areas of the species and cannot be formally separated.

Although the type collection of *H. multifida* should be at Kew, I have not seen it. There is a photograph of the type at the Bolus Herbarium and from this the nature of Lindley's *Disa multifida* is clear. There is some uncertainty about the type locality, which Drège indicates as 'Blauwberg'. It appears to be between Boskloof and Heuningvlei, near Clanwilliam in the northern Cedarberg.

Disa macroglottis Sond. ex Drège has to be treated as a *nomen nudum*, as the name, listed with a reference to an *Ecklon & Zeyher* collection, was published without a description.

11. *Herschelia hians* (L. f.) Hall in Flower. Pl. Afr. 42: t. 1674 (1973). Type: Cape of Good Hope, *Thunberg* s.n. (LINN, holo.!; UPS!).

Satyrium hians L. f., Suppl. Pl. 401 (1781). *Limodorum hians* (L. f.) Thunb., Prod. 3 (1793). *Disa hians* (L. f.) Spreng., Linn. Syst. Veg. 3: 698 (1826). *Eulophia hians* (L. f.) Spreng., Linn. Syst. Veg. 3: 720 (1826); Rolfe in Fl. Cap. 5, 3: 32 (1912).

Disa excelsa sensu Lindl., Gen. Sp. Orch. 356 (1838), non (Thunb.) Swartz; H. Bol. in J. Linn. Soc., Bot. 25: 203 (1889); Schltr. in Bot. Jb. 31: 292 (1901). *Herschelia excelsa* sensu Rolfe, in Fl. Cap. 5, 3: 200 (1913), non (Thunb.) Rolfe.

Disa lacera Swartz in Vet. Acad. Handl. 31: 212 (1800); Lindl., Gen. Sp. Orch.: 354 (1838); H. Bolus in J. Linn. Soc., Bot. 25: 202 (1889); Kraenzl., Orch. Gen. Sp. 1: 797 (1900); Schltr. in Bot. Jb. 31: 287 (1901). *Herschelia lacera* (Swartz) Fourc. in Trans. R. Soc. S. Afr. 21: 81 (1932). Type: Cape of Good Hope, *Sparrman* s.n. (W, holo.).

Disa outeniquensis Schltr. in Ann. Transv. Mus. 10: 246 (1924). Type: Cape Province, Mossel Bay District, Robinson Pass, *Bolus* 12327 (BOL, lecto!).

D. lacera Swartz var. *multifida* N. E. Br. in Gdnrs' Chron. 1888 2: 664 (1888). Iconotype: Gdnrs' Chron. 1888, 2, fig. 93 (1888).

Icons: Curtis's bot. Mag. 115: t. 7066 (1889); Flower. Pl. Afr. 42: t. 1674 (1973).

Plants 400–600 mm tall; tubers up to 20 mm long; base of the stem often with a sheath of old leaf fibres; radical leaves 8–13, often hysteranthous, reaching up to the base of the inflorescence or shorter, less than 2 mm wide, sclerophyllous with prominent veins, semi-rigid erect; cauline leaves completely sheathing, lax, acuminate, brown, 20–40 mm long; inflorescence lax, up to 200 mm long and with 3–16 flowers; bracts from half as long to as long as the ovaries, ovate to broadly ovate, acuminate to setaceous, dry; ovaries 15–20 mm long, slender, usually curved. Flowers varying in colour from very pale blue to purplish blue, the lip frequently darker coloured than the sepals; dorsal sepal erect, obtuse to more commonly acute, galea 10–15 mm long and 8–10 mm deep, ovate to broadly ovate; spur horizontally from the base of the galea, at length decurved, conical, tapering to a subacute apex, 4–6 mm long; lateral sepals patent, oblong-narrowly ovate to rarely narrowly oblong, usually rounded, rarely acute, the apical part subconduplicate, 8–12 mm long; petals with the basal anticus lobe broadly oblong, rounded or truncate, the margins entire or shallowly serrulate, subdecurrent with the limb, 3–4 mm long, the limb lorate, 7–10 mm long, the apex acute or rarely with the small tooth to the rear, curved falcately or geniculately upwards behind the anther; lip patent with the margins curved upwards, narrowly oblong, oblong or broadly elliptical, rarely broadly auriculate at the base, the margins rarely entire, the distal margin usually more or less crenulate to rarely lacerate, 7–12 mm long; anther horizontal, 2–3 mm long, viscidia separate; rostellum with 3 equal narrowly lanceolate lobes, 1 mm tall; stigma unequally 3 lobed with the odd lobe smaller than the lateral lobes, horizontal, 2–2.5 mm in diameter and on a 1 mm tall pedicel. Fig. 14.

Diagnostic features. Flowers with the lateral sepals 8–12 mm long; lip narrowly oblong to broadly elliptical, the margins entire or more commonly with the distal margin crenulate; petals with the limb lorate, the apex acute; spur 4–6 mm long.

Flowering time: December to January (–February).

Widespread and fairly common in the southern Cape Province on the coastal flats and the first range of mountains, occurring mostly on well-drained and often stony sandstone mountain slopes and flats (Fig. 15).

CAPE.—3419 (Caledon): Hermanus (–AC), Jan. 1920, *Burt Davy* 18483 (BOL). 3321 (Ladismith): Garcias Pass (–CC), Dec. 1977, *Linder* 1714 (BOL). 3322 (Oudshoorn): mountains near George (–CD), Jan. 1897, *Bolus* 13514 (BOL). 3422 (Mosselbay): near Sedgefield, near Knysna, 30 m (–BB), Oct. 1963, *Chater* s.n. (BOL; PRE; STE). 3323 (Willowmore): Outeniqua mountains near Joubertina (–DD), Jan. 1947, *Esterhuysen* 13599 (BOL; K; PRE). 3325 (Port Elizabeth): Port Elizabeth (–DC), Feb. 1889, *Galpin* 391 (PRE).

This species forms open scattered populations throughout the southern Cape Province, generally on well-drained and often stony soils. The rainfall in the area is almost evenly distributed over the whole year, and the total rainfall ranges from 600 to over 1 000 mm p.a. The altitude range of the species is from 80 m to over 1 000 m.

Extensive variation in flower colour and lip laceration occurs. The majority of populations investigated showed extraordinary colour variation, from pale sky-blue to deep purple-blue flowers. Colour variation commonly occurs within populations, but lip variation tends to be rather between populations. In the Knysna area the lip is occasionally entire. Despite extensive searching, I have failed to locate any such populations, but occasional herbarium specimens with entire lips are known from the Knysna area. Over the rest of the range the distal margin of the lip tends to be shallowly crenulate. In the Langeberg near Riversdale the lip frequently shows two broad auricles at the base, and the apex is variably shallowly lacerate (type of *D. lacera* Swartz agrees with this lip shape) (*Linder* 1714). Some collections from near Port Elizabeth also show lips that are variably lacerate (e.g. *Hall* 1160).

Hall (1973b) partially resolved the nomenclatural confusion surrounding the correct name for this taxon. *Satyrium hians* L. f. [= *Limodorum hians* (L. f.) Thunb.] was transferred to *Eulophia* by Sprengel and was mistaken for *Eulophia clavicornis* by subsequent botanists (Lindley, 1838; Bolus, 1889; Rolfe, 1912). Sprengel cited Thunberg's *Limodorum hians* as basionym. However, Sprengel had also transferred the epithet to *Disa*, citing *Satyrium hians* L. f. as basionym.

Thunberg (1794) proposed *Satyrium excelsum* as a *nomen novum* for *Orchis tripetaloides* L. f. As *Orchis tripetaloides* is a perfectly good name, *S. excelsum* has to be regarded as a superfluous name. Swartz (1800) transferred the epithet to *Disa*. Lindley (1838) noted that Thunberg's descriptions of *D. excelsa* (Thunb.) Swartz did not agree with the type of *O. tripetaloides* and maintained it as a distinct species. However, since the name is derived from a superfluous name, *Disa excelsa* sensu Lindley has to be regarded as an illegitimate name. The same then applies to *Herschelia excelsa* (Thunb.) Rolfe.

Disa lacera has generally been regarded as the same species as *D. venusta*. However, a study of the type found in Vienna showed that *D. lacera* agrees more with the form of *H. hians* found in the Langeberg at Riversdale than with *D. venusta*. Swartz's protologue, describing the lip as oblong, substantiates this finding, and *D. lacera* is included as a synonym under *H. hians*. The var. *multifida* which N. E. Brown described appears to be a more lacerate version of *D. hians*, of which a few collections from the Knysna area had been recorded. It does not show the characters of *H. venusta*.

Disa outeniquensis of Schlechter agrees in all characters with the most common form of *H. hians*.

12. *Herschelia forcipata* (Schltr.) Kraenzl., Orch. Gen. Sp. 1: 807 (1900); Rolfe in Fl. Cap. 5, 3: 200 (1913). Type: Cape, Trimen s.n. (BM, holo.!).

Disa forcipata Schltr. in Bot. Jb. 24: 428 (1897); in Bot. Jb. 31: 292 (1901).

Plant 600 mm tall; radical leaves and tubers not known; cauline leaves closely sheathing, acuminate, subimbricate, 40–50 mm long, dry; inflorescence laxly 25-flowered, 200 mm tall, cylindrical; bracts as long as the ovaries, lanceolate, acuminate, dry; ovaries slender, generally straight, c. 20 mm long. Flowers greenish yellow; dorsal sepal acute, galea broadly ovate, c. 13 mm long and 6 mm deep; spur horizontal from the base of the galea, slender cylindrical, straight, 3–4 mm long, the apex bifid; petals with a smaller orbicular basal anticonic lobe, decurrent with the limb, 2 mm in diameter, the limb lorate, geniculately curved up through 90° behind the anther, c. 10 mm long, the apex unequally bifid, the lobes acute, the anterior lobe longer than the posterior lobe; lip lanceolate, acute, the margins entire, c. 10 mm long; anther reflexed with the connective shorter than the cells; rostellum erect, trifid, the lobes acute; stigma pulvinate.

Diagnostic features. Lip lanceolate, acute, entire; petals with the apices bilobed, spur horizontal, slender, bifid.

This species is known from the single plant in Trimen's collection, made somewhere in the Cape in 1870, probably in the Knysna area (Schelpe pers. com). It is a very distinct taxon by virtue of the bilobed petals, the entire lip, the peculiar spur and rather dense inflorescence. It appears to be related to *H. hians*, rather than to the *H. graminifolia* group, as Schlechter (1897, 1901) and Rolfe (1913) suggested. The greenish yellow colour indicated by the collector, however, is reminiscent of *H. lugens*.

13. *Herschelia praecox* Linder, sp. nov., a *H. baurii* (H. Bol.) Kraenzl. labello fere integro, petalis pro ratione majoribus differt. Crescit in graminosis montis Nyikae Malaworum.

Type.—Zambia, Northern Province, Nyika Plateau, Sept. 1967, Williamson 312 (K, holo.!).

Plants 200–400 mm tall; tubers ovate, about 30 mm long; stems usually with a basal sheath of fibrous leaf remains; radical leaves produced after flowering, about 6, c. 300 mm long and 1–2 mm wide, semi-erect, subsclerophyllous; cauline leaves lax, acuminate, completely sheathing, c. 20 mm long; inflorescence laxly 2–10 flowered and 40–130 mm long; bracts ovate, acuminate, dry, about 10 mm long; ovaries 10–15 mm long, usually curved. Flowers white to blue or dark mauve, occasionally the apices of the petals green; dorsal sepal erect, galea acuminate with the apex reflexed, ovate, 10–12 mm tall, c. 8 mm wide and 4–6 mm deep; spur horizontal from the base of the galea, often gradually ascending, cylindrical to laterally flattened, rounded, c. 2 mm in diameter and 3–5 mm long; lateral sepals patent, narrowly ovate to lanceolate, subacuminate, 10–12 mm long, shallowly concave; petals with an ovate basal anticonic lobe, c. 2 mm in diameter, the limb lorate, falcately curved up next to the anther inside the galea, c. 12 mm long and 1.5–2 mm wide, the

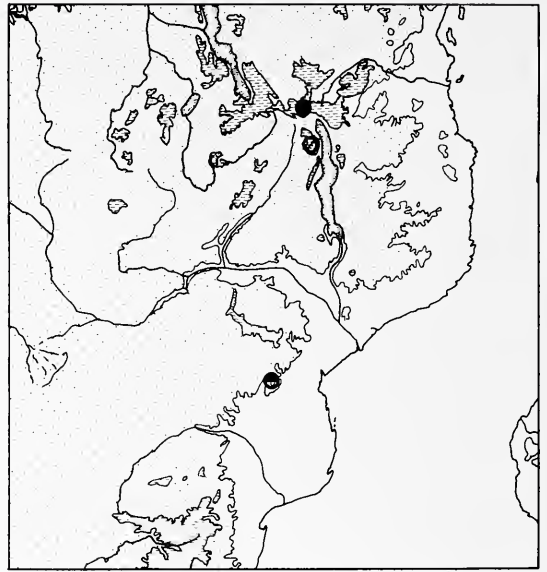


FIG. 19.—Distribution of *Herschelia praecox* (open circle), *H. goetzeana* (solid circle) and *H. chimanimaniensis* (half-solid circle).

apex widened and unequally acutely bilobed with the anterior lobe longer than the posterior lobe; lip narrowly ovate to lanceolate, 11–13 mm long, margins varying from almost entire to shallowly fimbriate, curved upwards; anther horizontal, c. 3 mm long, the connective longer than the anther; rostellum with 1.5 mm tall canalliculate erect lateral lobes; stigma subsessile, somewhat angled forwards. Fig. 20.

Diagnostic features. A short plant, flowering in September, shortly after the winter grass fires, re-

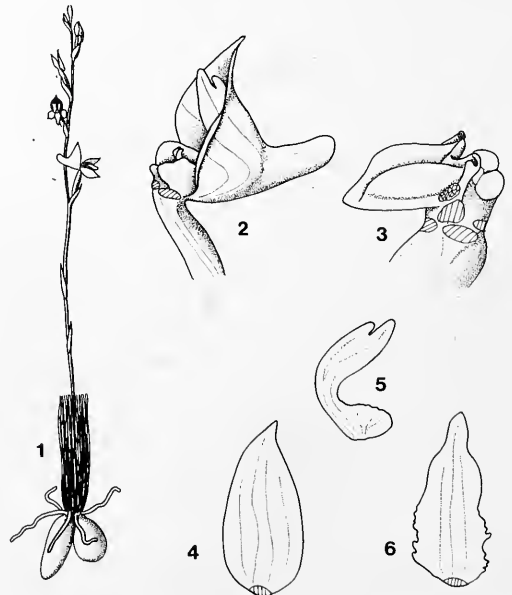


FIG. 20.—*Herschelia praecox*. 1, habit, $\times 0.5$. 2, flower with the lateral sepals and the lip removed, $\times 6$. 3, column, $\times 8$. 4, lateral sepal, $\times 6$. 5, petal, $\times 6$. 6, lip, $\times 6$. 1 from Tyrer 726, 2–6 from Williamson 312.

stricted to the montane grasslands on the Nyika Plateau, Malawi and Zambia.

MALAWI.—Northern Province, Rumphi District, Nyika Plateau, September 1962, *Tyrer* 966 (BM; SRGH).

ZAMBIA.—Northern Province, Lundazi District, Nyika Plateau, September 1964, *Robinson* 6259; September 1968, *Williamson* 1023 (K; SRGH).

The epithet '*praecox*' refers to the early flowering time, shortly after the winter fires.

H. praecox is very similar to *H. baurii*, and if it were compared with all the variations of the latter taxon over its whole range, it might be found difficult to maintain as a distinct taxon. The entire distribution area of *H. praecox* is included in that of *H. baurii*. In the overlap region, on the Nyika Plateau, the flowers of *H. baurii* are larger than anywhere in the rest of its range (Fig. 22), therefore creating a size differential from *H. praecox*. There is also a shift in flowering time: on the plateau, *H. baurii* flowers in October and November, whereas *H. praecox* flowers in September. This difference was also noted by Williamson (1977). Morphologically, the lack of deep dissection of the lip and the large petals provide substantiation for what is clearly a biological micro-species.

H. praecox grows in well-drained short montane grassland on the Nyika Plateau (Vesey-Fitzgerald, 1963; Chapman & White, 1970), under a rainfall regime of 1 000–2 000 mm p.a., mostly concentrated during the summer months. The winter months are dry, with occasional frost and frequent grass fires. *H. praecox* appears to flower after the fires, possibly before the first rains and before the grasses grow tall, therefore the flower spikes do not have to compete with the grasses and are consequently short. Leaves are only produced when flowering is completed, possibly after the rains start. As such, this species occupies the temporal niche before that of *H. baurii*.

14. *Herschelia baurii* (*H. Bol.*) *Kraenzl.*, *Orch. Gen. Sp.* 1: 804 (1900); *Rolfe* in *Fl. Cap.* 5, 3: 204 (1913). Type: Mt Baziya, *Baur* 814 (K, holo.!).

Disa baurii *H. Bol.* in *J. Linn. Soc., Bot.* 25: 174 (1889); *Schltr.* in *Bot. Jb.* 31: 289 (1901).

D. hamatopetala *Rendle* in *Trans. Linn. Soc.*, 2, 4: 47 (1894); *N. E. Br.* in *Fl. Trop. Afr.* 7: 286 (1898); *Summerh.* in *Fl. Trop. E. Afr.* 156: 177 (1968). *Herschelia hamatopetala* (*Rendle*) *Kraenzl.*, *Orch. Gen. Sp.* 1: 803 (1900). Type: Malawi, Mt Mlanje, *Whyte* s.n. (K, lecto.!).

Herschelia bachmanniana *Kraenzl.*, *Orch. Gen. Sp.* 1: 805 (1900). Type: Transkei, East Pondoland, *Bachmann* 414 (?B†).

Disa longilabris *Schltr.* in *Bot. Jb.* 38: 150 (1907). *Herschelia longilabris* (*Schltr.*) *Rolfe* in *Orch. Rev.* 27: 9 (1919). Type: Tanzania, Kinga Mountains, slopes of Mt Buongwe, *Goetze* 1222, 1226 (B, holo. †; Z!).

Icones: *H. M. L. Bol.* in *Ann. Bolus Herb.* 4: P1. 11 (1926); *Williamson*, *The orchids of south-central Africa*, P1. 71 (1977).

Plants 200–400 mm tall; tubers 20–30 mm long; base of the stem frequently with a thick sheath of old leaf fibres; radical leaves 5–10, produced after flowering, frequently overtopping the spike, up to 300 mm long and less than 2 mm wide, semirigid and subsclerophyllous; cauline leaves lax, completely sheathing, acuminate, 15–25 mm long, larger towards the base of the stem; inflorescence lax, rarely subsecund, with 2–14 flowers; bracts usually about ½ as long as the ovaries, rarely as long as the ovaries, ovate, acuminate, dry; ovaries straight or curved, 10–15 mm long. Flowers varying from pale sky-blue

to deep purple-blue, the lip frequently a darker blue than the sepals; dorsal sepal erect, galea ovate, acute, (8–) 10–20 mm tall, 6–12 mm wide and 5–10 mm deep; spur horizontal from the base of the galea, often somewhat ascending, cylindrical, rounded, 4–6 mm long; lateral sepals patent, oblong to rarely lanceolate, acute to rounded, (8–) 10–18 mm long, shallowly concave; petals with the basal antecolobous lobe oblong to ovate, 1–2.5 mm in diameter, rounded, the margin rarely crenulate, limb linear, 8–13 mm long, the apex variously expanded, deeply bifid to lacerate to acute; lip horizontal, at least at the base, broadly to narrowly ovate, 10–25 mm long, more or less deeply dissected; anther horizontal, 2–5 mm long, viscidia separate, ovate; rostellum erect, 2–3 mm tall, equally 3-lobed; stigma horizontal, 1 mm tall and 1.5–2.5 mm in diameter. Fig. 22.

Diagnostic features. Flowers with the lateral sepals 10–18 mm long; lip deeply and unevenly lacerate, generally longer than the lateral sepals; petals with usually a bilobed apex; spur generally cylindrical and obtuse,

Flowering time: mostly September and October, but with occasional collections from almost every month of the year.

A variable plant with hysteranthous leaves which occurs widespread in the montane grassland in southern and south-central Africa (Fig. 21), flowering at the beginning of the rainy season.

TRANSKEI.—3129 (Port St Johns): Msimkaba River mouth (–BA), Aug. 1976, *Venter & Vorster* 195 (PRE).

NATAL.—2929 (Underberg): Kamberg (–BD), Oct. 1941, *Schelpé* 013 (NU).

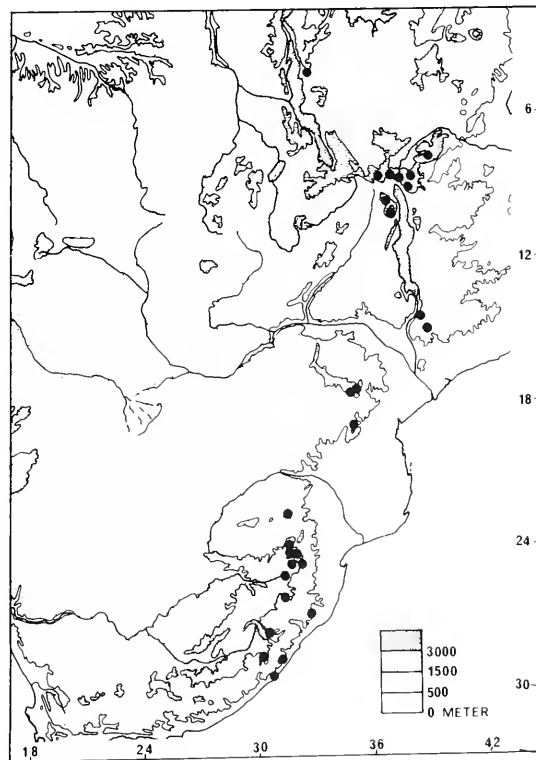


FIG. 21.—Distribution of *Herschelia baurii*.

SWAZILAND.—Sept. 1910, *Steward 8875* (PRE).

TRANSVAAL.—2630 (Carolina): Brereton P.S. (—CD), Sept. 1945, *Acocks 11731* (PRE). 2531 (Komatipoort): Saddleback Mountains, Barberton (—CC), Sept. 1889, *Galpin 427* (BOL, PRE). 2330 (Tzaneen): Woodbush Mountains (—CC), Sept. 1927, *Moss 15432* (PRE).

ZIMBABWE.—Melssetter District, Mt Musapa, 2100 m, *Wild 3556* (K; SRGH). Inyanga District, World's View, Sept. 1956, *Davies 2120* (K; SRGH). Inyanga District, head on Nyamazwi River, 1800 m Sept. 1965, *Biegel 257* (SRGH).

MALAWI.—Southern Province, Mulanje District, Mt Mlanje, 2 000 m, Oct. 1941, *Greenway 6318* (K). Northern Province, Rumph District, Nyika Plateau, Oct. 1958, *Robson 297* (K).

TANZANIA.—Southern Highlands, Njombe District, Elton Plateau, Nov. 1963, *Richards 18500* (K); Mbeya District, summit of Mt Mbeya, Oct. 1957, *Watermeyer 167* (K).

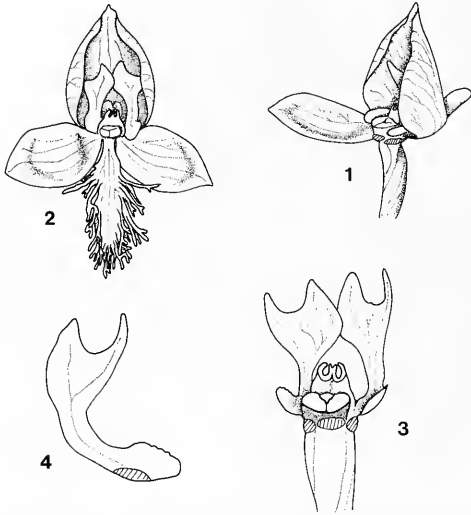


FIG. 22.—*Herschelia baurii*, from *Williamson 119*. 1, flower with the lateral sepal and the lip removed, $\times 1.5$. 2, front view of flower, $\times 1.5$. 3, front view of column and petals, $\times 3$. 4, petal, $\times 3$.

This species occurs in the grasslands of the Montane Region (White, 1978), between Grahamstown in the eastern Cape Province and Kigoma in western Tanzania. Robyns & Tournay (1955) also recorded this species from the Ruwenzori Mountains in Zaire. In general, the altitude range of these grasslands is from 1 000 to 2 400 m, and they receive approximately 1 000 to 1 500 m rainfall p.a., concentrated

in the summer months, usually with about four dry months in winter (Jackson, 1961; Phipps & Goodier, 1962; Chapman & White, 1970). Vesey-Fitzgerald (1963) notes that the grasslands are generally burnt in the winter months, after which the geophytes flower. During the rainy season the grasses grow rapidly, to flower at the end of the rainy season. *H. baurii* exploits the temporal niche at the beginning of the rainy season, before the grasses grow tall. This lack of height competition is manifested by the rather short flowering spikes. The leaves are produced after flowering is completed.

As might be expected from such a wide-ranging species, there is extensive geographical variation. Plants from Malawi tend to have much larger flowers, and relatively shorter spurs, than plants from Zimbabwe or South Africa (Fig. 23). In South Africa the petals usually do not have deeply bifid apices, but are narrowly obtriangulate towards the apex, often obliquely bifid or lacerate, whilst over the rest of the range the petals are deeply bifid. The geographical variation in flower size is shown in Fig. 23. This variation has been used to maintain separate taxa for South Africa and the areas north of South Africa (Summerhayes, 1968). However, a detailed study has shown that there is extensive overlap for all characters, with collections from Zimbabwe frequently intermediate between those from South Africa and those from Malawi.

In south Tanzania a smaller-flowered form occurs, which has been kept distinct as *Disa longilabris* by Summerhayes (1968). However, it only appears to be smaller in all its parts than *H. baurii*, and the characters mentioned by Summerhayes (1968) were found to be variable. However, there is little material of *D. longilabris* and the available evidence indicates that it is best treated as a depauperate form of *H. baurii*.

The type material of *H. bachmanniana* could not be traced. Kraenzlin (1900) notes that it is very similar to *H. baurii*, but that it possesses a much shorter spur, rounded sepals, dissected petals and flattened lip fimbriae. However, the type specimen of *D. baurii* is peculiar in that the spur is about twice as long as is typical for the species and this probably confused Kraenzlin. The other characters mentioned by Kraenzlin occur in *H. baurii*.

15. *Herschelia chimanimaniensis* Linder, sp. nov., a *H. baurii* (H. Bol.) Kraenzl. floribus minoribus, sepalis lateralibus 6–8 mm longis differt.

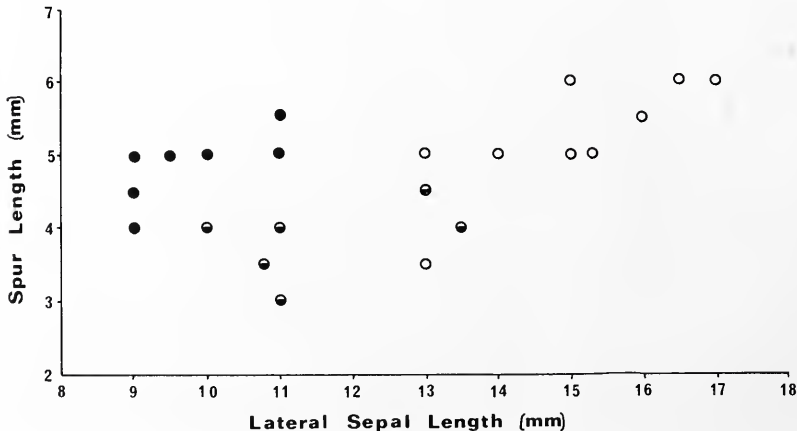


FIG. 23.—Geographical variation in flower size and spur length in *Herschelia baurii*. Material from South Africa plotted in solid circles, from Zimbabwe in half-solid circles and from Malawi and Tanzania in open circles.

Crescit in montibus Chimanimanorum Zimbabwe.

TYPE.—Zimbabwe, Chimanimani, Ball 577 (K, holo.; SRGH!).

Plants slender, 200–400 mm tall; base of the stem occasionally with a sheath of the fibrous leaf remains; radical leaves apparently produced after flowering, 3–6, 150–200 mm long and 1–2 mm wide, subsclerophyllous; cauline leaves closely sheathing, 4–8, 15–20 mm long, acuminate, the lower 2–3 much larger and imbricate; inflorescence laxly 2–8-flowered, 30–80 mm long; bracts ovate, acuminate, about half as long as the ovary, dry; ovaries 5–15 mm long. Flowers pink-mauve to white, rarely blue; dorsal sepal erect, galea ovate, acute, 5–7 mm tall, 4 mm wide and 4 mm deep; spur horizontal from the base of the galea, often gradually ascending, straight, cylindrical or somewhat laterally flattened, rounded, 3–4 mm long; lateral sepals patent, narrowly oblong–ovate, acute, 6–8 mm long, shallowly concave; petals with the basal anticus lobe ovate, 1–1.5 mm in diameter, the limb lorate, falcately curved up next to the anther, included in the galea, c. 5.5 mm long and 1 mm wide, the apex acutely bifid; lip ovate, 8–10 mm long, deeply dissected, the margins curved upwards; anther horizontal, c. 1.5 mm long; rostellum lateral lobes canalliculate, erect, 1–1.5 mm tall; stigma horizontal, c. 0.6 mm tall, flat, c. 1 mm in diameter. Fig. 24.

Diagnostic features. Plants slender, flowers small with the lateral sepals 6–8 mm long. Occurs in the Chimanimani Mountains of Zimbabwe.

Flowering time: September and October.

A small-flowered and very slender plant which occurs between about 1 500 and 1 800 m in the Chimanimani Mountains in eastern Zimbabwe and the neighbouring areas in Mozambique (Fig. 19).

ZIMBABWE.—Metsbet District, Chimanimani Mountains, Oct. 1950, Munch 327 (K; SRGH); Grosvenor 178 (K; SRGH).

MOZAMBIQUE.—Manica e Sofala District, Chimanimani Mountains, August 1964, Whellan 2145 (SRGH).

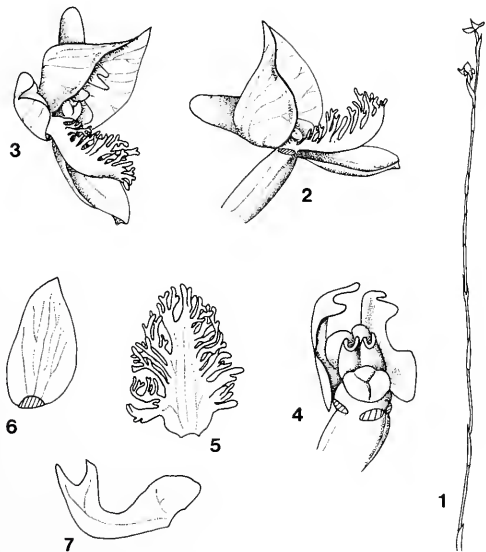


FIG. 24.—*Herschelia chimanimaniensis*, from Ball 577. 1, habit, $\times 0.5$; 2, flower with the lateral sepal removed, $\times 4$; 3, flower, $\times 4$; 4, front view of column and petals, $\times 8$; 5, lip, $\times 4$; 6, lateral sepal, $\times 4$; petal, $\times 4$.

From collectors' notes it appears as if the species has a wide ecological range, as it has been recorded from montane grassland, cliff faces, rocky ground, seasonally damp ground and bogs. Phipps & Goodier (1962) describe the climate as cool, with frequent mist in the summer and frequent frost in the winter months. Available records indicate that rainfall is highly dependent on local topography and varies from 800 to 3 000 mm p.a.

This new species is clearly closely related to *H. baurii*. The ecological relationships of the two taxa in the Chimanimani Mountains are not clear. The majority of collectors recognized the two taxa as being distinct and collected them under different numbers. It also appears as if *H. baurii* occurs at higher altitudes than *H. chimanimaniensis*, but no explicit data are available. *H. chimanimaniensis* may be distinguished by the smaller flowers and more slender habit.

Ser. *Ecalcaratae* Linder, ser. nov., labello lacero, calcar obsoleto dignoscenda. Flowers with a bearded lip, spur obsolete.

Type species: *H. goetzeana* Kraenzl.

The single species in this series is most peculiar. Although it is clearly related to ser. *Lacerae* in the bearded lip and petal shape, it differs from *H. baurii* in the absence of a spur and the acute entire petal. It is difficult to explain the origin of this species. If it cannot be derived from *H. baurii*, it must be seen as a relic of a previous expansion of *Herschelia* from the south.

16. *Herschelia goetzeana* Kraenzl. in Bot. Jb. 30: 286 (1901). Type: Tanzania, Njombe District, Bulongwa, Goetze 925 (B, holo. \dagger).

Disa goetzeana (Kraenzl.) Schltr. in Bot. Jb. 38: 150 (1906), in obs. non Kraenzl. (1900), nom. illegit. *D. walteri* Schltr. in Bot. Jb. 53: 544 (1915), nom. nov.; Summerh. in Fl. Trop. E. Afr. 156: 176 (1968).

Plants 200–600 mm tall; tubers about 20 mm long; base of the stem with a sheath of old leaf remains; radical leaves 5–10, 150–250 mm long and 1–3 mm wide, suberect, veins prominent, subsclerophyllous; cauline leaves lax, acuminate, about 25 mm long, completely sheathing; inflorescence closely 1–9-flowered; bracts ovate, acuminate, as long as the ovary, dry; ovaries about 10 mm long. Flowers foam-pink to crimson–cherry-coloured; dorsal sepal erect, galea hemispherical, almost orbicular from the front, 8–14 mm tall and 10–16 mm wide; spur obsolete; lateral sepal oblong, obtuse, spreading downwards, 10 mm long; petals with the basal anticus lobe oblong, 2 mm long, limb narrowly oblong to lorate, falcate, subacute, c. 7 mm long; lip patent, 20–25 mm long and up to 12 mm wide, entire at the base, obscurely 3-lobed, deeply and finely lacerate; anther horizontal, 7.5 mm long and with two distinct viscidia; rostellum with 3 linear erect lobes; stigma pulvinate, c. 2.5 mm in diameter.

Diagnostic features. Flowers with the lateral sepals c. 11 mm long; lip pectinate or lacerate; spur obsolete.

Flowering time: March.

Known from a single collection from southern Tanzania (Fig. 18), where it is said to be restricted to rock crevices on Mt Mbeya between 2 700 m and 2 900 m.

TANZANIA.—Southern Highlands, Mbeya District, Mbeya Peak, 2 700 m, March 1960, Kerfoot 1632 (K).

Kerfoot (1964) describes the vegetation of the Mbeya Range, and notes for the high-altitude lithophytic communities that cloud and mist occur frequently. Growth is highly seasonal, with flowering occurring between February and April, and the flora is dominated by Orchidaceae.

Morphologically, this species is quite distinct, but clearly related to the species in Ser. *Lacerae* It is therefore, other than *H. praecox* and *H. chinanimaniensis*, unlikely to be a neo-endemic. It is difficult to understand where this species fits in with the rest of the genus and in the classification proposed here it is anomalous. It would be most interesting to see more material of this species and to confirm its limited distribution.

The type collection has been lost, but from the description there cannot be any doubt about the identity of the species. The name 'goetzeana' cannot be transferred to *Disa*, as there is already a *Disa goetzeana* Kraenzl. Schlechter (1915) proposed *D. walteri* as a *nomen novum* for the species. The name is derived from Walter Goetze, the original collector of the species.

ACKNOWLEDGEMENTS

I am indebted to the various people with whom I have discussed this genus, and who criticized some of my ideas. I would especially like to thank my supervisor, Prof. E. A. Schelpe, for numerous comments and much patience. I am grateful to the Directors and Curators of the various herbaria where I was provided with working facilities, or who loaned material for study purposes. This research was done while holding a Smuts Fellowship and a CSIR Post-graduate bursary.

UITTREKSEL

Die genus Herschelia (Disinae, Orchidaceae) is *her-sien*. *Sestien spesies, een subspesie en een variëteit word erken. Twee nuwe spesies uit tropiese Afrika* (H. *chinanimaniensis* Linder en H. *praecox* Linder sowel as 'n nuwe variëteit ui die Kaap (H. *lugens* (H. Bolus) Kraenzl var. *nigrescens* Linder] word hier beskryf. Drie nuwe koinbinasies word gemaak deur die oorpasing van die twee spesies van Forficaria en Disa seksie Micropistera (een spesie) na Herschelia. Dertien spesies word geïllustreer en die nomenklatuur en die beskikbare gegewens in verband met die groeiplekke van die taksons word bespreek. Die spesies is in twee subgenera gegroepeer waarvan een in twee verdere seksies en vier series verdeel is. Hierdie klassifikasie is gebaseer op die veronderstelde filogenie soos bepaal deur die metode opgestel deur Wagner (1962).

REFERENCES

ANONYMOUS, 1905. Horticultural notes. *J. Hort.* 3, 51: 123.
 BENTHAM, G. & HOOKER, J. D., 1883. *Genera Plantarum*. London.
 BOLUS, H., 1882. Notes on some Cape orchids. *J. Linn. Soc., Bot.* 19: 233–238
 BOLUS, H., 1884. Contributions to South African botany. *J. Linn. Soc., Bot.* 20: 467–488.
 BOLUS, H., 1888. The orchids of the Cape Peninsula. *Trans. S. Afr. phil. Soc.* 5: 1–201.
 BOLUS, H., 1889. Contributions to South African botany. Part IV. *J. Linn. Soc., Bot.* 25: 156–209.
 BOLUS, H., 1893. *Icones Orchidearum Austro-Africanarum* 1 (1). London: Wesley.
 BOLUS, H., 1896. *Icones Orclidearum Austro-Africanarum* 1 (1). London: Wesley.
 BOLUS, H., 1907. Contributions to the African flora. *Trans. S. Afr. phil. Soc.* 16: 135–152.
 BOLUS, H., 1911. *Icones Orchidearum Austro-Africanarum* 2. London: Wesley.

BOLUS, H., 1913. *Icones Orchidearum Austro-Africanarum* 3. London: Wesley.
 BOLUS, H. M. L., 1926a. *Disa lacera*. *Flower. Pl. Afr.* 6: t. 234.
 BOLUS, H. M. L., 1926b. South African orchids. *Ann. Bolus Herb.* 4: 62–67.
 BOLUS, H. M. L., 1931. *Disa forficaria*. *Flower. Pl. Afr.* 11: t. 415.
 BREMER, K. & WANNITROP, H., 1978. Phylogenetic systematics in botany. *Taxon* 27: 317–329.
 BROWN, N. E., 1888. *Disa lacera* Swartz and var. *multifida* N. E. Br. (n. var.). *Gdnrs' Chron.* 3: 664
 BROWN, N. E., 1889. Orchideae. In W. T. Thiselton-Dyer (ed.), *Flora of Tropical Africa* 7. London: Reeve.
 DAVIS, P. H. & HEYWOOD, V. H., 1963. *Principles of angiosperm taxonomy*. Edinburgh: Oliver & Boyd.
 DREGE, J. F., 1847. Vergleichungen der von Ecklon und Zeyher und von Drege gesammelten suedafrikanischen Pflanzen. *Linnaea* 20: 183–258.
 DYER, R. A., 1955. *Herschelia graminifolia*. *Flower. Pl. Afr.* 30: t. 1172.
 DYER, R. A., 1976. The genera of Southern African flowering plants. 2. *Gynnosperms and monocotyledons*. Pretoria: Botanical Research Institute.
 DURAND, T. & SCHINZ, H., 1894. *Conspectus florae Africae* 5. Brussels: Charles van de Weghe.
 FOURCADE, H. G., 1932. Contributions to the flora of the Knysna and neighbouring divisions. *Trans. R. Soc. S. Afr.* 21: 75–102.
 FUNK, V. A. & STUESSY, T. F., 1978. Cladistics for the practising plant taxonomist. *Syst. Bot.* 3: 159–178.
 GOLDBLATT, P., 1978. An analysis of the flora of southern Africa: its characteristics, relationships, and origins. *Ann. Miss. Bot. Gard.* 65: 369–436.
 HALL, A. V., 1973a. *Disa charpentieriana*. *Flower. Pl. Afr.* 42: t. 1673.
 HALL, A. V., 1973b. *Herschelia hians*. *Flower. Pl. Afr.* 42: t. 1674.
 HENNIG, W., 1966. *Phylogenetic systematics*. Urbana: University of Illinois Press.
 HOLMGREN, P. K. & KEUKEN, W., 1974. *Index Herbariorum, Part I*. The herbaria of the world. Utrecht: Oosthoek, Scheltema & Holkema.
 HOOKER, J. D., 1886. *Disa atropurpurea*. *Curtis's bot. Mag.* t. 6891.
 HOOKER, J. D., 1889. *Disa lacera* var. *multifida*. *Curtis's bot. Mag.* t. 7066.
 JACKSON, S. P. (ed.), 1961. *Climatological atlas of Africa*. Lagos: CCTA/CSA.
 JUDD, W. S., 1979. Generic relationships in the Andromedeae (Ericaceae). *J. Arnold Arbor.* 60: 477–503.
 KERFOOT, O., 1964. A preliminary account of the vegetation of the Mbeya Range, Tanganyika. *Kirkia* 4: 191–205.
 KRAENZLIN, F., 1900. *Orchideacearum Genera et Species*. Berlin: Mayer & Mueller.
 KRAENZLIN, F., 1901. Beiträge zur Flora von Africa. *Bot. Jb.* 30: 280–289.
 LINDER, H. P., 1981. Taxonomic studies in the Disinae. IV. A revision of *Disa* Berg. sect. *Micranthae* Lindl. In Preparation.
 LINDLEY, J., 1830–1840. *The genera and species of orchidaceous plants*. London.
 LINNAEUS, C. (fil.), 1781. *Supplementum Plantarum*. Brunsvigae.
 MASON, H., 1972. *Western Cape Sandveld flowers*. Cape Town: Struik.
 PFITZER, E., 1889. Orchidaceae. In A. Engler & K. Prantl (eds), *Die natürlichen Pflanzenfamilien*. Leipzig: Wilhelm Engelmann.
 PHIPPS, J. B. & GOODIER, R., 1962. A preliminary account of the plant ecology of the Chimanimani Mountains. *J. Ecol.* 50: 291–391.
 REICHENBACH, H. G., 1847. Orchidiographische Beiträge. *Linnaea* 20: 673–696.
 RENDLE, A. B., 1894. The plants of Mlanji, Nyasaland. *Trans. Linn. Soc.* 2, 4: 1–68.
 RICE, E. G. & COMPTON, R. H., 1950. *Wild flowers of the Cape of Good Hope*. Cape Town: Botanical Society of South Africa.
 ROBYNS, W. & TOURNAY, R., 1955. *Flore des Spermatophytes du Parc National Albert. III. Monocotylées*. Bruxelles.
 ROLFE, R. A., 1912. *Disa lugens*. *Curtis's bot. Mag.* t. 8415.
 ROLFE, R. A., 1912–1913. Orchidaceae. In W. T. Thiselton-Dyer (ed.) *Flora Capensis* 5, 3. London: Reeve.
 SCHELPE, E. A., 1966. *An introduction to the South African orchids*. Cape Town: Purnell.
 SCHLECHTER, R., 1897. Orchidaceae africanae novae vel minus cognitae. *Bot. Jb.* 24: 418–433.
 SCHLECHTER, R., 1901. Monographie der Diseae. *Bot. Jb.* 31: 134–313.
 SCHLECHTER, R., 1906. Orchidaceae africanae. IV. *Bot. Jb.* 38: 144–165.
 SCHLECHTER, R., 1915. Orchidaceae Stolzianae, ein Beitrag zur Orchideenkunde des Nyassalandes. *Bot. Jb.* 53: 477–605.
 SCHLECHTER, R., 1924. Contributions to South African orchidology. *Ann. Transv. Mus.* 10: 233–252.

- SENGHAS, K., 1973. Orchidoideae. In R. Schlechter, *Die Orchideen*, ed. 3. Paul Parey.
- SONDER, G., 1847. Enumeratio Orchidearum, quas in Africa Australi Extratropicum collegerunt C. F. Ecklon, Dr., et C. Zeyher. *Linnaea* 19: 71–112.
- SPRENGEL, C., 1826. *Linnaea Systema Vegetabilium* 3. Göttingen.
- STAFLEU, F. A., et al., 1978. *International code of botanical nomenclature*. Utrecht: Bohn, Scheltema & Holtema.
- SUMMERHAYES, V. S., 1968. Orchidaceae, Part 1. In E. Milne-Redhead & R. M. Polhill (eds), *Flora of Tropical East Africa* 156. London.
- SWARTZ, O., 1800. Orchidemes slagter och arter upstalldes. *Kong. Vet. Acad. Handl.*, Stockholm 31: 202–254.
- THUNBERG, C. P., 1794. *Prodrounus Plantarum Capensium*. Uppsala.
- VESEY-FITZGERALD, D. F., 1963. Central African grasslands. *J. Ecol.* 51: 243–274.
- WAGNER, W. H., 1962. A graphic method for expressing relationships based upon group correlations of indexes of divergence. In L. Benson, *Plant taxonomy, methods and principles* 415–417. New York: Ronald Press Co.
- WHITE, F., 1978. The afro-montane region. In M. J. A. Werger (ed.), *Biogeography and ecology of southern Africa*. The Hague: Junk.
- WILLIAMSON, G., 1977. *The orchids of south central Africa*. London: Dent.

APPENDIX: SPECIMENS STUDIED

The specimens are listed alphabetically according to the name of the collector. The figures in brackets refer to the number of the taxon in the text. Herbaria from which each collection has been studied are indicated by the letter codes of Holmgren and Keuken (1974).

Acocks 2087 (6) S; 3678 (10) S; 11731 (14) PRE. *Alchenck* 549 (5) Z. *Andraea* 278 (5) STE. *Atherstone* 29 (9a) K.

Baker 37 (6) K. *Ball* 577 (15) K, SRGH. *Balsinhas-Kersberg* 2054 (14) PRE. *Barker* 56 (4a) NBG; 620 (11) NBG; 625 (11) NBG; 3042 (4a) NBG; 444 (6) NBG; 4785 (4a) NBG; 5760 (4a) NBG; 6043 (11) NBG; 8476 (6) NBG; 8828 (11) NBG. *Barkley* in BOL 4884 (5) BOL. *Bayliss* 3067 (11) NBG; 4162 (11) NBG. *Benson* 149 (13) BM; 189 (13) BM. *Bergius* s.n. (5) P. *Biegel* 257 (14) BOL, SRGH. *Bodkin* 494 (9a) BOL, K, SAM. *Bolus* 494 (9a) BOL, K, SAM; 1552 (11) BOL; 3810 (9a) BM, BOL, GRA, PRE, Z; 4393 (4a) PRE; 4566 (8) BM, BOL, K, PRE; 4566b (7) BM; 4857 (7) BOL, GRA, K; 4893 (6) BOL, GRA, K; 5278 (10) BOL, K; 7992 (6) Z; 9788 (14) BOL, K; 11379 (5) GRA; 11645 (10) BOL, PRE; 12327 (11) BOL, BR; 13514 (11) BOL; 17494 (8) BOL; s.n. (46) BOL; s.n. (5) BOL; (6) SAM; s.n. (8) BOL; s.n. (11) BOL. *Bond* 878 (11) NBG. *Bowie* 12 (5) BM; 13 (4a) BM; s.n. (11) BM. *Breach* s.n. (10) BOL. *Britten* 1058 (11) GRA, PRE; 6575 (9a) GRA. *Brook* s.n. (4a) PRE. *Buchanan* 1016 (14) K. *Buchholz* s.n. (5) STE. *Buhr* 5 (11) BOL. *Burchell* 747 (11) K; 808a (5) K; 7001 (5) K; 7801 (5) K; 4572 (11) K; 4592 (11) K; 7182 (11) K; 7372 (5) W. *Burt* 1915 (14) K; 4245 (5) PRE; 12004 (11) PRE; 18483 (11) BOL; 22070 (14) K; s.n. (14) BOL.

Carter & Barres s.n. (4a) BOL. *Chapman* 148 (14) BM; 330 (14) BM, SRGH. *Chase* 2949 (14) BM, BOL, K; 4059 (14) SRGH. *Chater* s.n. (11) BOL, PRE. *Clarke* in NBG 2184/31 (9a) BOL. *Codd* 523 (14) BM, PRE; 9714 (14) GRA, K, PRE, UPS. *Collins* 1538 (4a) K. *Compton* 4150 (4a) BOL, NBG; 4515 (11) BOL, NBG; 10499 (5) NBG; 12322 (6) NBG; 16644 (8) NBG; 20236 (6) NBG; 24487 (14) NBG; 25150 (14) NBG; s.n. (5) BOL. *Cookson* 3 (14) PRE, SRGH. *Cooper* 1464 (11) BM, K, W; *sub Eyles* 2743 (14) PRE, SRGH. *Cresswell* s.n. (9a) SAM. *Crook* 136 (14) SRGH; 409 (14) K, SRGH. *Crundall* s.n. (14) PRE. *Culver* 20 (14) BM, BOL, BR, K. *Cuthbert* 5 (14) K. *Cutting* s.n. (9a) BOL; s.n. (11) BOL.

Dahlstrand 2586 (11) GRA. *Daly & Sole* 527 (9a) GRA. *Davidson* s.n. (4a) SAM. *Davies* 2120 (14) PRE, SRGH; s.n. (4a) SAM. *Dart* s.n. (9a) BOL, STE. *Delhaye* s.n. (14) K. *Dennan* 237 (11) GRA. *De Villiers* s.n. (11) STE. *De Vos* 738 (8) PRE. *Doe* s.n. (8) BOL. *Drège* 1234 (4a) K, P; 2211a (11) K, W; s.n. (5) SAM; 63 (11) GRA. *Drummond* 8956 (14) SRGH; 8981 (14) SRGH; 8982 (15) SRGH. *Dümmen* 756 (9a) BM; 1502 (14) BM. *Duthie* 1027 (11) STE. *Du Toit* s.n. (9a) BOL. *Dyer* 229 (9a) PRE.

Ecklon 1565 (9a) W. *Edwards* 2157 (14) NU; s.n. (14) BOL. *Esterhuysen* 3802 (10) BOL; 4628 (11) BOL; 7298 (10) BOL; 8207 (4a) BOL; 13599 (11) BOL, K, PRE; 13664 (5) BOL; 15154 (5) K, PRE; 17441 (4a) BOL, PRE; 19990 (5) BOL; 20353 (4a) BOL; 20907 (10) BOL; 22712 (5) BOL, K. *Eyles* 2743 (14) PRE, SRGH.

Fair in BOL 3810 (9a) PRE; in BOL 7992 (6) BOL, GRA, PRE. *Ferguson* s.n. (3) BOL; s.n. (11) BOL. *Flugge-De Smit* s.n. (5)

BOL. *Fourcade* 542 (11) GRA; 548 (5) BOL, GRA; 3167 (9a) K; 4309 (11) K, STE; 4344 (4b) BOL; 6443 (4b) PRE. *Franks* 9810 (14) PRE. *Froenling* s.n. (9a) NBG. *Frowein* 16131 (8) PRE.

Galpin 294 (9a) PRE; 427 (14) BOL, GRA, K, PRE, SAM; 428 (14) GRA; 4917 (5) PRE; 12545 (5) PRE. *Garley* 167 (14) SRGH. *Garside* 46 (9a) K, PRE. *Gemmell* 5037 (11) PRE. *Gerloin* 249 (11) GRA. *Germain* 1563 (14) BR. *Gillet* 326 (11) K; 718 (1) BOL; 1602 (4b) BOL; 17648 (14) K, PRE; 17799 (14) K; s.n. (5) STE; s.n. (9a) K; s.n. (11) BOL. *Gillet & Bolus* in BOL 18506 (11) BOL. *Gillies* 107 (14) NU. *Glass* s.n. (9a) GRA, PRE. *Goatcher* s.n. (4a) BOL. *Goetze* 1222 (14) BM. *Grant* 2464 (4a) BR, M, PRE; s.n. (14) BM. *Gretnay* 6318 (14) K, PRE. *Grice* s.n. (14) NU. *Grosvenor* 178 (15) K, SRGH; 257 (14) K, SRGH. *Gueinzus* s.n. (10) W. *Guthrie* 871 (4a) BOL; 4383 (11) NBG; 8384 (11) NBG; in BOL 6861 (10) GRA.

Hafström & Acocks 2087 (6) PRE, Z, S. *Hall* 664 (9a) BOL; 1043 (4a) BOL; 1160 (11) BOL. *Hallack* in BOL 6210 (11) BOL, GRA. *Hall-Martin* 429 (14) PRE. *Handel Hamer* in BOL 16964 (11) BOL. *Harvey* 116 (9a) K; 148 (7) K; s.n. (5) BM, K, W. *Harwood* s.n. (14) PRE. *Hayes Palmer* s.n. (11) NBG. *Haynes* 304 (5) STE; 528 (5) STE. *Hendrickx* 3465 (14) PRE. *Hermann* 871 (4a) NBG. *Hill* 2 (14) K. *Hilliard & Burt* 10404 (14) NU. *Huysteen* s.n. (6) STE.

Immelmann 246 (4a) BOL.

Jaimes in BOL 23178 (11) BOL. *Jameson* s.n. (6) K. *Jenkins* 8228 (14) PRE. *Jeppe* in PRE 3383 (5) PRE; in PRE 33384 (4b) PRE; in PRE 33385 (11) PRE. *Johnson* s.n. (14) K. *Joubert* s.n. (5) K.

Karsten s.n. (14) NBG. *Keet* 1154 (11) GRA. *Kennedy* s.n. (5) PRE. *Kensley* 280 (11) GRA. *Kensit* 9339 (8) BOL. *Kerfoot* 1632 (16) K. *Kettle* 18 (13) PRE. *Kettlewell* in BOL 25392 (6) BOL. *Keulder* s.n. (9a) STE. *Kirk* s.n. (14) K. *Kolbe* 2412 (9a) GRA. *Krauss* s.n. (5) M.

Lavis s.n. (4a) BOL. *Leach* 4121 (14) K, SRGH; 14941 (14) BOL, SRGH; 21121 (14) S. *Lees* 99 (14) K. *Leighton* 402 (4a) BOL; 3067 (11) BOL, PRE. *Leipoldt* 601 (4a) BOL; 3233 (4a) BOL; 3234 (4a) BOL; 3810 (4a) BOL; 4243 (11) BOL; in BOL 11379 (5) PRE; s.n. (4a) BOL. *Lewis* 828 (8) SAM; 1837 (4a) SAM; 2402 (6) SAM; 2404 (7) SAM; 2680 (4a) SAM; 4737 (4a) SAM; 5202 (4a) NBG. *Liebenberg* 7805 (11) K, PRE. *Linder* 759 (6) BR, BOL; 1244 (4a) BOL; 1245 (4a) BOL; 1453 (4a) BOL; 1458 (4a) BOL; 1460 (4a) BOL; 1471 (4a) BOL; 1549 (4a) BOL, BR, K; 1656 (10) BOL; 1714 (11) BOL; 1729 (11) BOL; 1731 (11) BOL; 1743 (10) BOL; 1763 (5) BOL; 1806 (7) BOL. *Long* 165 (9a) K; 494 (9a) K; 507 (11) K, PRE; 520 (11) K, PRE. *Luyt* in BOL 10571 (3) BOL, PRE; 11379 (5) BOL.

MacOwan 700 (9a) BM, GRA, K, SAM; 1045 (11) BM, GRA, K, SAM; 1045b (5) SAM, W; 2587 (4a) SAM; 2690 (9a) SAM; s.n. (5) NBG. *MacOwan & Bolus* 166 (7) BM, BOL, K, P, W, ZT; 167 (5) BM, BOL, K, P, SAM, UPS, W, ZT; 494 (9a) BOL, P, PRE, W, Z, ZT. *MacNicol* s.n. (11) NBG. *Magennis* s.n. (4a) BOL, PRE. *Mahon* s.n. (14) K. *Marloth* 332 (6) BOL, PRE; 425 (5) PRE; 483 (10) PRE; 1601 (9a) BOL; 2310 (4a) PRE; 6678 (10) BOL, PRE; 7273 (7) PRE; 7941 (4a) PRE; 8337 (10) PRE; 8435 (4a) PRE; 8847 (9a) PRE; 10061 (11) PRE; 11008 (9a) PRE; s.n. (5) BOL; s.n. (6) SAM. *Marsh* 1408 (4b) PRE, SRGH. *Matthews* 28 (14) SRGH. *Mauve* 5005 (14) PRE. *McClounie* 10 (14) K; 92/3 (14) BM. *McLoughlin* 362 (14) BOL; 92/3 (14) K, P, PRE, S, UPS; s.n. (11) BOL. *Mgaza* 488 (14) K. *Michael* et al. 971 (13) SRGH. *Middelemost* 1721 (4a) NBG; 1954 (11) NBG. *Minicki* s.n. (1) BOL. *Moorshead* *sub Moss* 17594 (11) BM. *Morris* 52 (14) K; in BOL 13478 (4a) BOL. *Moss* 15432 (14) K, PRE; 17594 (11) BM, 18237 (11) BM. *Muir* 621 (11) PRE; 908 (9a) BOL, PRE, SAM; in PRE 16266 (9a) PRE; s.n. (4a) PRE. *Munch* 274 (14) SRGH; 327 (15) K, SRGH. *Myburg* s.n. (9a) NBG.

Newbould & Jefford 1849 (14) K. *Newdigate* in BOL 6327 (2) BOL; s.n. (11) BOL.

O'Brien s.n. (9a) BM; s.n. (11) K, Z. *O'Connor* 216 (14) NU; 368 (14) NU. *Oldeve-Roberts* s.n. (11) S. *Oliver* 3181 (9a) PRE, STE; 3006 (6) PRE; in STE 29974 (10) PRE.

Pappe 38 (4a) SAM; 39 (9a) BOL, SAM; 377 (9a) BOL, GRA, SAM; in BOL 4393 (4a) BOL; s.n. (4a) K; s.n. (11) K, SAM. *Parker* s.n. (6) BOL. *Paterson* 106 (5) GRA; 488 (11) GRA, Z; 1277 (11) BOL, GRA; s.n. (6) BOL. *Pattison* in BOL 14455 (10) BOL. *Pawek* 1409 (13) SRGH; 3800 (14) K; 10275 (14) SRGH. *Penther* 50 (11) BM, M, W; 154 (5) M, W; 251 (4a) W; in PRE 10575 (11) PRE. *Peters* s.n. (4a) SAM. *Pillans* 3530 (6) PRE; 4056 (5) PRE; 4125 (1) BOL; 8275 (8) BOL; 9723 (10) BOL. *Plowes* 2807 (15) K, SRGH; 2808 (14) K, SRGH. *Pott* 1278 (9a) PRE. *Powrie* 168 (10) BOL. *Prentice* s.n. (4a) PRE.

Rattray in BOL 15770 (8) BOL. *Rauh & Schlieben* 9761 (14) M, PRE. *Rehmen* 529 (11) BM, Z; 571 (5) Z. *Reynolds* 4200 (14) PRE.

Richards 6804 (14) K; 18500 (14) K; 22561 (14) K; 22574 (14) K, P. *Robinson* 6259 (13) K, M, SRGH. *Robson* 297 (14) K; 358 (14) BM, K, SRGH. *Rogers* 10550 (5) Z; 16554 (11) Z; 19079 (14) PRE; 19767 (14) GRA, K, P, S; 21404 (14) BOL, K, Z; 26487 (11) Z; 26865 (11) Z; 27643 (11) Z; 30155 (14) BR, K, P, Z. *Rosenbruck* in BOL 27817 (1) BOL. *Rycroft* 2559 (4a) NBG. *Ryder* in NBG 40/28 (11) BOL, K; s.n. (3) K.

Salter 8703 (8) NBG; 325/1 (5) BM; 325/2 (6) BM; 325/3 (7) BM; 325/4 (8) BM; in SAM 53195 (8) SAM. *Schelte* 013 (14) NU; 826 (14) NU; 4267 (11) BOL; 4994 (11) BOL; 5006a (11) BOL; 6313 (9a) BOL. *Schlechter* 481 (5) P, Z; 2061 (5) BOL, Z; 4997 (4a) PRE, Z; 5165 (4a) BOL, GRA, P, W, Z; 5928 (11) Z; 9544 (8) BM, BR, GRA, K, PRE; s.n. (4a) BR, K. *Schlieben* 1366 (14) BM, G, M, P, S, Z. *Schmidt* 3 (5) M. *Schnisterhol* 213 (5) S. *Schonland* 1519 (9a) GRA, Z; 2410 (9a) PRE; 3662 (11) GRA; sub *Galpin* 4917 (5) PRE. *Seltzer* s.n. (9a) NBG. *Seltzer & Parke* s.n. (9a) BOL. *Shirley* 234 (14) NU. *Sidey* 490 (14) PRE; 1498 (14) PRE, S; 4057 (11) PRE. *Sim* 2457 (14) BOL, PRE. *Skead* 210 (14) NU. *South* 127 (9a) GRA; s.n. (11) GRA, PRE. *Stander* s.n. (11) STE. *Starke* 127/27 (11) BOL; NBG 60/27 (11) BOL. *Stewart* 8875 (14) GRA, PRE. *Stokoe* 2560 (1) BOL; 7324 (5) BOL, SAM; 7386 (5) BOL; 8679 (10) BOL; in SAM 54389 (11) SAM; in SAM 54714 (11) SAM; s.n. (5) SAM. *Stolz* 127 (14) BM, G, K, M, W, Z; 2192 (14) C, G, M, S, W, Z; 2193 (14) C, G, M, Z. *Strey* 9853 (14) PRE. *Sturgeon* in SRGH 30524 (14) K, SRGH. *Symons* 22 (14) SAM; in PRE 14847 (14) PRE.

Taylor 191 (14) NU; 634 (11) NBG; 1713 (14) NU; 1755 (14) NU; 1786 (14) NU, SRGH; 1791 (15) NU; 5455 (9a) STE; 6220 (5) STE. *Tennant* 5 (5) NBG. *Thode* A48 (5) PRE; A387 (14) K, PRE; A1022 (11) K, PRE; in STE 5247 (5) STE; in STE 5307 (11) STE; in STE 6104 (5) STE; in STE 6526 (11) STE; in STE 8128 (5) STE. *Thomas* s.n. (4a) NBG; s.n. (6) NBG. *Thorncroft* 2478 (14) K, PRE. *Thornton* s.n. (14) PRE. *Thulin & Mhoro* 1201 (14) K, UPS; 1207 (14) K. *Thunberg* 21429 (9) UPS; 21443 (11) UPS. *Trauseld* 412 (14) PRE. *Trimmen* s.n. (12) BM; s.n. (9a) BM. *Tyrer* 726 (13) BM, SRGH; 966 (13) BM, SRGH; 978 (13) BM. *Tyson* 1537 (14) BOL.

Wahlberg s.n. (5) S. *Wall* s.n. (3) S; s.n. (4a) S; s.n. (5) S; s.n. (9a) S; s.n. (11) S. *Wallich* 113 (11) BM. *Watermeyer* 167 (13) K. *West* 256 (11) W. *Westwood* 694 (14) SRGH. *Whellan* 1493 (11) SRGH; 2137 (14) SRGH; 2145 (15) SRGH. *Whyte* 345 (14) K; s.n. (14) K; s.n. (14) K. *Wild* 1366 (14) K, SRGH; 3556 (14) PRE, SRGH; 4668 (14) SRGH; 4669 (14) K. *Willan* 176 (14) K; in BOL 24915 (14) BOL. *Williamson* 119 (14) K; 312 (13) K; 1023 (13) K, SRGH. *Wilms* 1406 (14) BM. *Wolley-Dodd* 358 (9a) BM; 359 (7) K; 391 (8) BM, K; 840 (5) BM; 885 (5) K; 1798 (9a) K; 2005 (6) BM, K. *Wood* 9290 (14) BOL, K; 10599 (14) K, PRE. *Worsdell* s.n. (4a) K; s.n. (9a) K; s.n. (14) K. *Wright* 2412 (14) NU. *Wurts* 558 (5) NBG; 2136 (11) NBG. *Wylie* sub *Wood* 10599 (14) GRA, PRE, SAM; in *Dümm* 1502 (14) BM.

York 34 (9a) K.

Van Zinderen Bakker 56 (11) NBG. *Venter* 848 (14) PRE. *Venter & Vorster* 195 (14) PRE; 196 (14) PRE. *Vogelpoel* s.n. (14) BOL. *Voigt* in PRE 13199 (14) PRE.

Zeyher 504 (11) P; 628 (11) K; 1566 (9a) K, S, SAM; 1567 (7) K, P, SAM, W; 3917 (11) S; 3918 (10) BM, K, P, S, W; s.n. (5) SAM; s.n. (6) K. *Zinn* s.n. (5) SAM.

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An analysis of the African *Acacia* species: their distribution, possible origins and relationships

J. H. ROSS*

ABSTRACT

The three subgenera recognized within the genus *Acacia* are outlined and the global distribution of each is indicated. The differences between the subgenera and the degree of relationship and levels of specialization are discussed briefly. It is suggested that the ancestral members of the genus were climbers or lianes. Past geological events considered likely to have influenced the distribution of the *Acacia* species in Africa are outlined. The number of species recorded from each African country is tabulated and the distribution and concentration of species within the genus *Acacia* as a whole and within each subgenus in Africa are illustrated. The highest concentrations of species within each subgenus occur in tropical east and south-east Africa. The distribution of species within some of the individual African countries and possible affinities are discussed and attention is drawn to the main centres of endemism. The distribution of the African species is correlated with the major phytogeographical regions recognized on the continent. The relationships between the African and the American, Madagascan, Indian and Australian *Acacia* species are discussed briefly.

RÉSUMÉ

UNE ANALYSE DES ESPÈCES D'ACACIA AFRICAINS: LEUR DISTRIBUTION, ORIGINES EVENTUELLES ET RELATIONS

Les trois sous-genres reconnus dans le genre *Acacia* sont esquissés et la distribution globale de chacun est indiquée. Les différences entre les sous-genres et le degré de relation et niveaux de spécialisation sont brièvement discutés. Il est suggéré que les membres ancestraux du genre étaient des grimpeurs ou des lianes. Des événements géologiques du passé considérés comme avoir vraisemblablement influencer la distribution des espèces d'*Acacia* en Afrique sont décrits. Le nombre des espèces enregistrées dans chaque pays d'Afrique a été présenté sous forme de tables et la distribution ainsi que la concentration des espèces dans le genre *Acacia* dans son ensemble et dans chaque sous-genre d'Afrique sont illustrés. Les concentrations les plus élevées d'espèces dans chaque sous-genre surviennent en Afrique tropicale orientale et sud-orientale. La distribution des espèces dans certains pays africains individuels et les affinités possibles sont discutées et l'attention est attirée sur les centres principaux d'endémisme. La distribution des espèces africaines et des espèces d'*Acacia* américaines, malgaches, indiennes et australiennes est brièvement discutée.

INTRODUCTION

The genus *Acacia* at present consists of about 1 100 species (perhaps as many as 1 200) which are widely dispersed in the Americas, the Caribbean and Pacific Islands, Africa, Madagascar and the Mascarenes, Asia, the Indo-Malesian region and Australia. Europe is the only large geographical area devoid of indigenous *Acacia* species, and there are no indigenous species in New Zealand despite its relative proximity to Australia. The fossil record indicates that the genus was previously more widely distributed having been present formerly in the Ukraine (Shchekina, 1965) and in New Zealand (Mildenhall, 1972, 1975). Most species of *Acacia* occur in regions where the rainfall is markedly seasonal or low, relatively few inhabiting rainforest areas, but even then the rainfall is usually unevenly distributed throughout the year and even in the wettest parts there is usually a short dry season. This does not imply that the genus originated in an arid or semi-arid region. On the contrary, it is considered probable that *Acacia* originated in the tropical lowlands and that most of the xerophytic features within the genus are secondary.

Much evidence has accumulated in recent years to support the contention that there have been large scale movements of continents during geological time and Raven & Axelrod (1974) summarized the biogeographic support for the theory of plate tectonics. Raven & Axelrod (*l.c.*) postulated that West Gondwanaland, combined Africa and South America, was a primary area of evolution for many major orders of

angiosperms and perhaps the earliest angiosperms themselves, and that the initial radiation of the angiosperms occurred when direct migration was possible between South America, Africa, India, Antarctica and Australia, and via Africa to Laurasia. West Gondwanaland included vast arid to subhumid areas in tropical latitudes where the terrain and edaphic conditions were diverse and provided every opportunity for rapid evolution. Thorne (1977), on the other hand, favoured south-eastern Asia and associated archipelagoes as the primary centre of origin of the most primitive angiosperms and maintained that prior to its fragmentation West Gondwanaland was merely one of a number of important centres for the development of the tropical angiosperm flora.

In support of their contention Raven & Axelrod (*l.c.*) argued that West Gondwanaland was centrally located on routes of dispersal at the time when the primary evolutionary radiation of the angiosperms was taking place. The climatic changes associated with the fragmentation of Gondwanaland, which, according to Raven & Axelrod, commenced in the mid-Cretaceous approximately when the first angiosperms are encountered in the fossil record, probably had a profound influence on the evolution of the angiosperms and on the establishment of major lines within it. There is some disagreement over the timing of the fragmentation of Gondwanaland, an event of primary importance from a phytogeographic point of view. Melville (1975), for example, was of the opinion that Gondwanaland started to fragment earlier than indicated by Raven & Axelrod. In this paper I have followed Raven & Axelrod in assuming that

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Gondwanaland started to fragment in the mid-Cretaceous and that the angiosperms were already fairly widely distributed.

The opening of the South Atlantic 125–130 million years ago heralded the spread of more mesic climates over much of West Gondwanaland and is thought to have started the surge of angiosperms into the mesic lowland record about 110 million years ago (Raven & Axelrod, *l.c.*). The pattern of appearance of the angiosperms in the lowland record suggested to Raven & Axelrod that the primitive members of several extant orders and perhaps even a few families were already in existence by the close of the early Cretaceous 110 million years ago. Thorne (1978), however, maintained that few, if any, extant families, and certainly no extant genera, had evolved in West Gondwanaland before the final sundering of South America from Africa 100 million years ago.

Raven & Axelrod (*l.c.*) expressed the opinion that most modern angiosperm families were in existence in the Paleocene about 65 million years ago before the connection between Africa and Eurasia was severed. The family Leguminosae is thought to have originated or at least have undergone its primary radiation and differentiation into three subfamilies in West Gondwanaland and Raven & Axelrod expressed the view that Mimosoideae, Caesalpinoideae and perhaps Papilionoideae were in existence by the Paleocene. There are no reliable Cretaceous records of Caesalpinoideae or of the other two subfamilies. From what can be inferred about its history and present distribution patterns, Raven & Axelrod presume that Mimosoideae migrated between Africa and South America during or prior to the Paleocene. After the Paleocene (54 million years ago) the evidence suggests only limited migration between these two continents.

Vassal (1972) recognized three subgenera within *Acacia*, namely, subgenera *Acacia*, *Aculeiferum* and *Heterophyllum**, chiefly on the basis of characters of seeds and seedlings and on the occurrence of stipular spines and pollen characters. The three subgenera recognized by Vassal broadly correspond to groupings of Bentham's six series which is fortunate as most of the characters on which Vassal's classification are based are not obvious from the gross morphology of conventional herbarium specimens. The relationship between Bentham's series and Vassal's subgenera is as follows:

1. Subgenus *Aculeiferum* Vassal (=series *Vulgares* Benth. and series *Filicinae* Benth.)
2. Subgenus *Heterophyllum* Vassal (=series *Phyllodineae* Benth., series *Botryocephalae* Benth. and series *Pulchellae* Benth.)
3. Subgenus *Acacia* (=series *Gummiferae* Benth.)

The following sections within each subgenus were proposed by Vassal (1972) and Guinet & Vassal (1978) and the names are used in this paper:

1. Subgenus *Aculeiferum* (Sections *Aculeiferum*, *Monacantha* and *Filicinae*)
2. Subgenus *Heterophyllum* (Sections *Heterophyllum*, *Uninervea* and *Pulchelloidea*)
3. Subgenus *Acacia* (Section *Acacia*)

*The subgeneric name *Phyllodineae* (DC.) Seringe has priority and will have to be adopted in place of *Heterophyllum* Vassal, but the name *Heterophyllum* is retained for the purpose of this paper.

GLOBAL DISTRIBUTION OF THE GENUS *ACACIA*

An indication of the global distribution of each subgenus is given in Figs 1–3.

The distributions of subgenera *Acacia* and *Aculeiferum* are very similar but subgenus *Acacia* apparently enjoys a slightly wider distributional range than subgenus *Aculeiferum*. Subgenus *Aculeiferum* has a more restricted distribution in Africa than subgenus *Acacia*, is present in New Guinea while subgenus *Acacia* is absent, and only just reaches Australia (in the vicinity of Coen in northern Queensland) where it is represented by a solitary species (*A. albizioides* Pedley) in contrast to subgenus *Acacia* which is widely distributed in northern Australia although represented by fewer than ten species. The vast majority of species in the genus belong to subgenus *Heterophyllum* which is fundamentally an Australian group (including Tasmania), while a further eighteen species (Pedley, 1975) occur in Madagascar and the Mascarenes, New Guinea, Formosa, the Philippines and the Pacific Islands to Hawaii. The genus reaches its southern limit of distribution in Tasmania. The position of *A. willardiana* Rose, which occurs on the west coast of North America (Mexico), is not clear (see later discussion) but if it is placed in subgenus *Heterophyllum* as advocated by Vassal & Guinet (1972) then the distribution of the subgenus shown in Fig. 3 should be extended eastwards from Hawaii to Mexico.

Guinet & Vassal (1978) are of the opinion that the three subgenera were differentiated by the Oligo-Miocene period (\pm 27 million years ago), and that no fundamental difference seems to exist between their geographical distribution then and the present. They pointed out that the apparent absence of the genus in the fossil record during the Paleocene is surprising, particularly if the genus is held to have had a monophyletic origin and if one considers that its distribution during the Neogene was what it is now.

ORIGIN AND POSSIBLE IDENTITY OF THE ANCESTRAL MEMBERS OF THE GENUS *ACACIA*

Like the origin of the angiosperms, the identity of the ancestral form of *Acacia* has been the subject of much speculation and disagreement, but recently a broad consensus appears to have been reached which contradicts the earlier views of Andrews (1914) and Atchison (1948). Andrews and Atchison considered the *Gummiferae* (subgenus *Acacia*) to be the ancestral form as its members contained the morphological characters of the genus that they considered to be primitive, namely, bipinnate leaves and persistent spinescent stipules. Atchison maintained that chromosome number variation, morphological uniformity and geographical distribution contributed toward establishing *Gummiferae* as the ancestral form of the genus pointing out, in support of this contention, that *Gummiferae* is the only section of the genus with a cosmopolitan distribution (this is not strictly correct). The other sections of the genus were held to have developed from the original forms in secondary centres where isolation through climatic or edaphic change was favourable to the survival of new types. Tindale & Roux (1975), on the basis of a limited sample, suggested that the chemical content of the South African species with non-spinescent stipules (subgenus *Aculeiferum*) is generally more advanced than that of the species with spinescent stipules (subgenus *Acacia*), a suggestion that supports the above view. However, most of the *Gummiferae* are polyploids and polyploidy is now held to

FIG. 1.—An indication of the global distribution of subgenus *Acacia* (excluding the distribution of *Acacia farnesiana* in Australia).

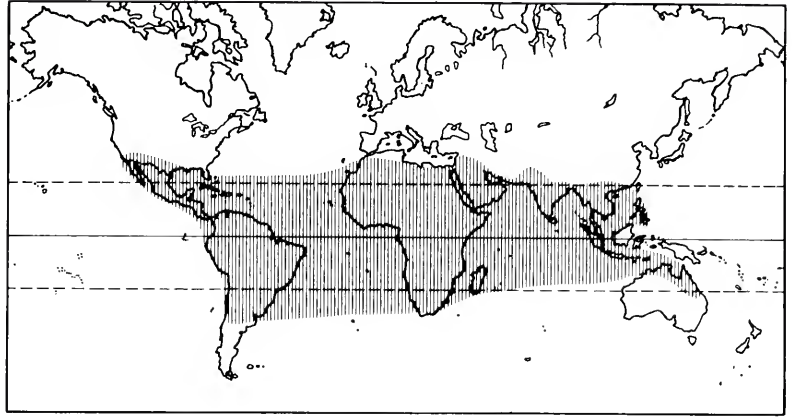


FIG. 2.—An indication of the global distribution of subgenus *Aculeiferum*.

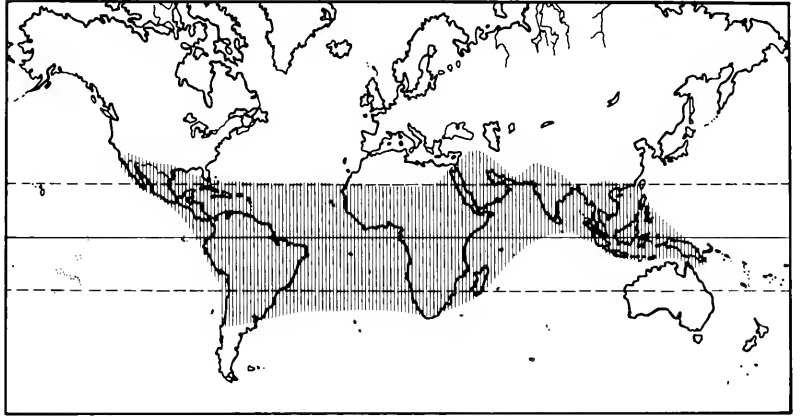
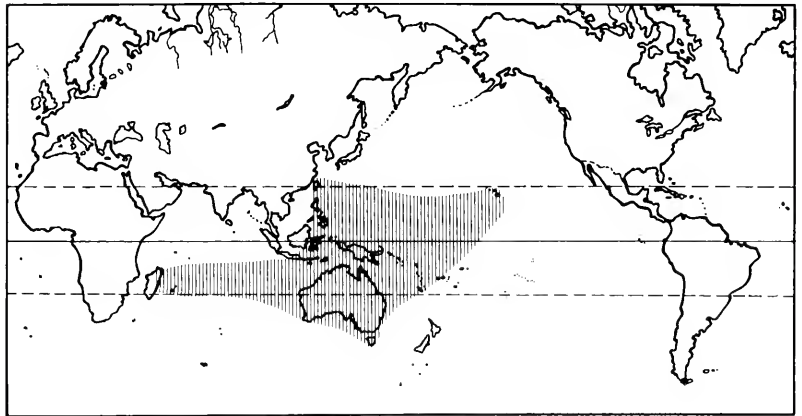


FIG. 3.—An indication of the global distribution of subgenus *Heterophyllum* (excluding *A. willardiana* which probably belongs in subgenus *Aculeiferum*).



correspond to a high degree of differentiation in the genus *Acacia*.

Robbertse (1974) outlined the possible evolution of the inflorescence and flowering system in the South African acacias and considered subgenus *Acacia* (*Gummiferae*) to be more advanced than subgenus *Aculeiferum* (*Vulgares*), a view which is supported by the detailed studies of Guinet & Vassal (1978). Robbertse considered it probable that the paniculate flowering system, spicate inflorescence, pedicellate flowers, presence of a cup-shaped disc and a pedicel-

late ovary, all of which are found in subgenus *Aculeiferum*, are primitive characters.

Guinet & Vassal (1978) evaluated the degree of relationship and specialization of the major subdivisions recognized within the genus on the basis of pollen, chromosome, seed, pod, inflorescence and vegetative characters. Each character was divided into three states, namely, unspecialized, specialized and highly specialized, and that section of the genus displaying the characters considered to be highly specialized was itself considered to be highly special-

ized. The division of some characters, for example seed size, into somewhat arbitrary size classes is questionable, especially as it was not disclosed why the range of continuous variation in seed size was divided in such a manner or what criteria were employed to establish the degree of specialization of each size class. For example, seed were divided into the following size classes, small (less than 5 mm long), medium (5–10 mm long) and large (more than 10 mm long). Small seed were regarded as unspecialized but it is quite conceivable that in some instances small seed may be specialized. In addition, the range of variation in seed size in many species obscures the limits of Guinet & Vassal's size classes.

Guinet & Vassal (*l.c.*) concluded that:

1. On the basis of pollen morphology subgenus *Acacia* is the most specialized of the three subgenera and subgenus *Aculeiferum* the least specialized. Although the pollen of subgenus *Heterophyllum* is generally more specialized than that of subgenus *Aculeiferum*, the two subgenera share important characters, for example, the absence of columellae and the presence of simple apertures.

2. Subgenus *Acacia* is clearly distinguished from the other two subgenera by the high level of specialization of the chromosome characters (chromosome numbers and the degree of homogeneity of the karyotype). Subgenera *Aculeiferum* and *Heterophyllum* are more homogeneous and have similar levels of differentiation of chromosome characters. On the basis of chromosome characters, subgenus *Aculeiferum* is the least specialized and subgenus *Acacia* the most specialized.

3. The characters of the seeds of subgenus *Acacia* are often highly specialized, and the levels of specialization in the series *Filicinae* and *Monacantha* of subgenus *Aculeiferum* are fairly close.

4. The cotyledonary and adult foliar characters selected did not appear to be specialized in subgenera *Aculeiferum* and *Acacia* except in a few rare cases, while many specializations occurred in subgenus *Heterophyllum* except in the development of spinescence. Section *Filicinae* of subgenus *Aculeiferum* shows no specialized characters.

5. The characters of the inflorescence and pod selected indicated that certain characters in subgenus *Acacia* are infrequently encountered in the other subgenera.

Guinet & Vassal attempted to estimate the total levels of specialization within each subgenus (and within the sections within each subgenus) and concluded that:

1. On the basis of their average level of specialization subgenus *Acacia* is the most specialized subgenus and *Aculeiferum* the least specialized.

2. Section *Filicinae* of subgenus *Aculeiferum* is characterized by a preponderance of unspecialized characters and shows the least diversity of all series in the genus.

3. Section *Monacantha* of subgenus *Aculeiferum* contains more possible primitive states than section *Aculeiferum* and appears to be less advanced than the latter.

4. The *Phyllodineae* are more specialized than the *Botryocephalae* and the *Pulchellae* in subgenus *Heterophyllum* but the persistence of unspecialized states occurs to a similar degree in the three series.

Guinet & Vassal (*l.c.*) stressed that if the correlation of the characters selected reflects a true relationship between the major subdivisions of the genus, then subgenera *Aculeiferum* and *Heterophyllum* are more closely related to one another despite the fact that they occupy basically different geographical areas which show relatively little overlap, than are subgenera *Aculeiferum* and *Acacia* which share a common geographical area.

Guinet & Vassal favoured the concept that *Acacia* originated in West Gondwanaland in an area that approximates to the area presently occupied by Central America (from Mexico to Bolivia). In support of this contention Guinet & Vassal pointed out that characters which are absent in the genus *Acacia* itself in America are nevertheless found in indirectly related genera. For example, the fundamentally Australian extraporate pollen type (subgenus *Heterophyllum*) exists in some South American genera closely related to *Piptadenia*, and phyllodes are present in some South American species of *Mimosa*. These occurrences were regarded by Guinet & Vassal as evidence that the American continent contains most of the evolutionary potential for the characters now found in the genus *Acacia* and accords with Guinet's (1969) earlier suggestion that phyllodes and the pollen type commonly found in subgenus *Heterophyllum* may have originated in South America and that Australia was a secondary centre of development and differentiation. However, because of the occurrence in Australia of phyllodes and the pollen type alluded to, it can equally well be argued that Australia also contains most of the evolutionary potential for the characters now found in the genus *Acacia* and that these characters originated in Australia. Guinet & Vassal are of the opinion that section *Filicinae* of subgenus *Aculeiferum* preserves the morphological characters closest to those postulated as being ancestral in the genus. Section *Filicinae* is poorly known and much more information is required.

The rainforest areas of the world were previously much more extensive and during the Paleogene humid forests stretched through much of America, Africa, Arabia, India, Malaysia and Australia. *Acacia* species are not well represented in rainforest areas at the present time and it is thought that this is probably due to their general intolerance of low light intensities. In the absence of any indications to the contrary, it seems reasonable to assume that members of the genus have always been similarly intolerant of low light intensities. The *Acacia* species which are currently the most successful in rainforest areas are the climbers and it appears as though the climbing habit has enabled species to exploit situations in forests where light penetrates to the ground, for example in clearings, on the banks of streams or on forest margins, and reach and maintain an emergent position in the canopy. If, as is considered likely, *Acacia* originated in lowland forests, it is suggested that the ancestral members were climbers or lianes and, this being the case, members of proto-*Aculeiferum* which were similar in some respects to some members of subgenus *Aculeiferum*.

Taking the African species as an example, a number of the members of section *Monacantha* subgenus *Aculeiferum* appear to be obligate climbers (*A. lujae* De Wild., *A. kraussiana* Meisn. ex Benth.) while others (*A. brevispica* Harms, *A. ataxacantha* DC.) occur as climbers in forested areas or as scan-

dent shrubs or even large spreading shrubs in neighbouring woodland or grassland areas. *A. ataxacantha* occurs as a climber in forests and on forest margins, as a scandent shrub or non-scandent spreading shrub in woodland or grassland, but on occasions it grows as a substantial single-stemmed tree up to 10 m high in southern Africa. *A. ataxacantha* apparently exhibits the evolutionary potential that would have been necessary for a forest-dwelling climber to adapt and exploit the new habitats created in surrounding grassland and woodland areas as the forests retreated.

A. ataxacantha and the other climbers are invariably armed with scattered recurved non-stipular prickles but occasional plants are entirely or almost entirely unarmed. Some species [*A. caffra* Thunb.) Willd., *A. galpinii* Burt Davy, *A. polyacantha* Willd.] in section *Aculeiferum* of subgenus *Aculeiferum* which are typically armed with prickles in pairs at the nodes are likewise sometimes unarmed. In some species (*A. caffra*) in section *Aculeiferum* occasional specimens are found where a few irregularly scattered prickles occur *in addition* to the paired prickles at the nodes. This illustrates the apparent ease with which scattered or paired prickles can be lost and how scattered prickles could give rise to paired or solitary prickles at the nodes or vice versa. Once again, the evolutionary potential for such change is still apparently present. Members of the American section *Filicinae* which Guinet & Vassal consider to be ancestral are typically unarmed but prickles could have been lost as indicated.

Although subgenera *Acacia* and *Aculeiferum* share a common geographical area there are fundamental differences between them, as indicated by Guinet & Vassal, and they do not appear to be closely related which suggests that subgenus *Acacia* did not arise directly from subgenus *Aculeiferum* or vice versa. For example, the colporate pollen of subgenus *Acacia* with columellae is considered unlikely to have developed from the porate type without columellae. It seems more likely, therefore, that subgenus *Acacia* was derived from proto-*Aculeiferum* rather than from subgenus *Aculeiferum* itself. Subgenus *Heterophyllum* was possibly derived directly from subgenus *Aculeiferum* or, failing that, from proto-*Aculeiferum*.

It is difficult to speculate on the identity of the ancestral proto-*Aculeiferum* except very generally. It is suggested that the ancestral members were climbers or lianes, either unarmed or armed with prickles, with many-jugate bipinnate leaves. Robbertse's (1974) findings suggest that they would have possessed a paniculate flowering system and that the flowers were pedicellate. The transition from capitate to spicate inflorescences and vice versa appears to have occurred several times during the development of the genus and there is no certainty as to which condition might be considered unspecialized.

OUTLINE OF THE CRETACEOUS-QUATERNARY HISTORY OF AFRICA

The present distribution patterns in *Acacia* in Africa have been determined by events that lie deep in the past but it is difficult to assess, except very generally, the effects of past geological events on the flora of a continent. Unfortunately the plant fossil record in Africa is generally poor from the Jurassic until the Quaternary (Plumstead, 1969), largely because of the uplift of the continent following the break-up of Gondwanaland and the limited extent of

lowland basins in which fossils were preserved. Consequently little information is available during the time that the angiosperms evolved and became dominant during the Cretaceous. According to Axelrod & Raven (1978), who provided an excellent survey of the late Cretaceous and Tertiary in Africa, the vegetation of Africa since the middle Cretaceous has been shaped by diverse physical factors, and in its broadest features the vegetation history in Africa has paralleled that of other austral continents which have remained relatively stable in latitude since the Cretaceous. A summary follows of the more important features of the Cretaceous-Quaternary history of Africa, largely as outlined by Axelrod & Raven.

During the late Cretaceous and Paleocene (75–55 million years ago) Africa lay 15–18° further south than at present. Relief was relatively low and a lowland rainforest stretched from coast to coast clothing nearly all of Africa except perhaps for the southern tip; the late Cretaceous and Paleocene rainforest covered much of North Africa which was then situated near the equator and what is now the Sahara desert. This was a period of benevolence during which rains were reliable and the widespread forests flourished, although even at this time isolated pockets of aridity are likely to have existed at the edge of the tropics because of high pressure cells and in edaphically dry sites in both tropical and temperate zones (Axelrod, 1972). The southern part of the continent, which came under the influence of the westerlies, probably had a cool wet climate (Goldblatt, 1979). At this time all of the temperate austral lands were covered with a dense *Podocarpus*–*Nothofagus* evergreen dicot temperate forest and consequently it is inferred that a forest flora of the *Podocarpus*–*Nothofagus* type (*Nothofagus* was not necessarily present) probably covered the southern tip of southern Africa. The inferred distribution of vegetation in Africa during the late Cretaceous–Paleocene is illustrated by Axelrod & Raven, Fig. 6 (1978) along with that during the late Oligocene–early Miocene, middle–late Miocene and Recent.

By the close of the Cretaceous, Africa was isolated from South America and India-Madagascar and was surrounded by ocean. Although direct migration of plants to and from Africa was restricted after the mid-Cretaceous, direct interchange with South America was much easier than at present as the Atlantic was relatively shallow and numerous islands provided stepping stones between the two continents (Raven & Axelrod, 1974).

By the close of the Oligocene, the African plate had moved north to virtually its present position. During the late Oligocene–early Miocene (30–25 million years ago) the low relief in Africa was altered by uplift accompanied by warping (King, 1967), especially along the east coast, and the present landscape of the continent started to take shape. Volcanic activity started on a major scale and the East African rift valleys were initiated. Uplift brought a cooler drier climate and the development and spread of dry climate over tropical Africa probably began near the close of the Oligocene about 27 million years ago (Axelrod, 1972) and has continued to the present as the rift valleys continue to grow (Raven & Axelrod, 1974). The formation of a volcanic field from Ethiopia southwards down the rift valleys during the Miocene increased the development of rainshadows which in turn brought greater drought and temperature extremes.

As a result of the Neogene trend to a drier climate brought on by the general uplift of the continent, changes in circulation, and the resultant decrease in moisture, savanna started to spread at the expense of rainforest and the African rainforest was progressively impoverished. The development of rainshadows in the rift valleys favoured the spread of savanna and then grassland, at first locally in small patches but then more extensively as the rainshadow effect increased. By the mid Miocene lowland rainforest is thought to have had only a patchy distribution along the northern parts of the east coast, and it seems probable that a temporary dry season during which little or no rain fell was already evident in the Miocene.

By the close of the Oligocene–early Miocene the vegetation of Africa had assumed a near-modern aspect although the composition and distribution of vegetation differed in many important respects from that of today (see Axelrod & Raven, Fig. 6, 1978).

A further major factor that affected the African flora was the development of the cold Benguella current. By the early Miocene Antarctica had moved to its present position and glaciation had been initiated. When glaciation commenced in Antarctica cold water started to bathe the west coast of Africa bringing to it a drier colder climate. A full ice sheet did not appear until the Pliocene about 5 million years ago and it waxed and waned for 2–3 million years. As the major ice sheet spread the Benguella current increased in strength and became progressively colder bringing with it increased drought to the west coast of tropical Africa. The extensive Pliocene ice sheet would have brought a much drier climate not only to the coast of west tropical Africa but it may possibly also account for the dry global climate in the mid Pliocene (Raven & Axelrod, 1974).

As aridity spread and a seasonally dry climate became established, particularly during the Pliocene as the Antarctic ice cap developed, the African rainforest continued to be more and more restricted in distribution and impoverished and the taxa comprising the forests became progressively more discontinuous. The strengthening high pressure systems brought a drier climate to the interior of Africa and the spreading drought tended to disrupt and impoverish the African flora, the recurring aridity in the tropics during successive periods of 'ice-age aridity' resulting in increased selection pressure for drought resistant taxa. As a consequence, rainforest areas were replaced by savanna and grassland, savanna and grassland by dry thorn scrub and dry thorn scrub by semidesert and desert vegetation.

The later phases of this trend in the Pliocene probably resulted in the appearance of local areas of semidesert, but widespread regional semideserts and deserts are apparently the consequence of later phases of 'ice-age aridity'. According to Quezel (1979), a desert climate was probably initiated in the major part of the Sahara, at least in the lower altitudinal zones, during the Pliocene.

Throughout the Tertiary there was a symmetrical distribution of climate and vegetation in the central tropical belt. The present African vegetation shows much greater asymmetry than that of the early to late Tertiary (see Axelrod & Raven, Fig. 6, 1978). White (1965) discussed the marked differences that exist at present between the Sudanian and Zambeian floristic domains. The Sudanian Domain is much drier than the Zambeian and its greater aridity has been

largely responsible for the impoverishment of its flora.

The close of the Pliocene and the early Pleistocene were characterized by major uplifting which raised the interior plateaux by over 1 700 metres. The altitude of parts of eastern Africa has increased by over 2 000 metres above that of the Miocene and has brought to it a drier climate. The Pliocene–Pleistocene uplifting and associated climatic fluctuations favoured local speciation.

Fluctuations in the Quaternary climate also had a significant effect on the tropical African rainforest flora, with the drier periods being times of extinction of taxa requiring more or less continuously wet conditions. Rainforest expanded during the humid interglacial periods and contracted again during the dry glacial periods. Wild (1968) reconstructed tentative vegetation maps of Zimbabwe showing how the vegetation would have differed from that of today if rainfall decreased by 50% or increased by about 150% above present levels. Wild demonstrated that if rainfall increased by 150% above present levels, Zimbabwean forests that are now isolated would have been sufficiently widespread to have been in contact with the main forest areas of Zaire and West Africa which would explain why some species in isolated Zimbabwean forests have west African affinities. Wild suggested that Quaternary pluvials of only 50% higher rainfall would probably have resulted in more or less continuous forest at lower altitudes through much of tropical Africa, but Axelrod & Raven (1978) considered this unlikely unless a considerable amount of rain fell during the present dry winter season so that the rainfall was fairly evenly distributed throughout the year, a situation which was itself considered unlikely because of the strength of the then prevailing anticyclonic circulatory systems. Axelrod & Raven suggested that the present links in forest taxa between the Zaire–West Africa and the relic forest patches in Zimbabwe may date from the early Miocene.

Even during the past 20 000 years there have been major climatic changes over much of Africa (Van Zinderen Bakker, 1974) emphasizing that continued existence is not possible without continuous change. The tropical African rainforests continue to contract rapidly as a consequence of human activities and probably to a lesser extent because of climatic changes.

It is against this background of continuous change that the present distribution of the *Acacia* species must be seen. Just as the present distributions differ from those of the past, so too will those of the future differ from those of the present. Indeed, the present conservation status of a number of species is uncertain, especially of some of the endemic species with restricted distributions in the Horn of Africa.

ANALYSIS OF THE AFRICAN *ACACIA* SPECIES

The number of species recorded from each country in Africa is indicated in Table 1, the countries corresponding with the usual political boundaries except that, for the sake of convenience, the territory of the Afars and Issars has been included with Somalia. Table 1 was compiled from data contained in a conspectus of the African species (Ross, 1979) which was itself based on an examination of specimens in several African, British and European herbaria and on information contained in the regional African floras. The African *Acacia* species remain incompletely known and numerous taxonomic problems

await elucidation, especially in north-east tropical Africa. For the purpose of Table 1 and in the discussion which follows the 115 species accepted by Ross (1979) have been taken as the number of species for the continent (this figure excludes *A. macrothyrsa* Harms which is now considered (Hunde, 1979) to be a synonym of *A. amythetophylla* A. Steud. ex A. Rich.). Taxa such as *A. farnesiana* (L.) Willd., which is not thought to be indigenous, and *A. schlechteri* Harms and *A. andongensis* Welw. ex Hiern, about whose precise taxonomic status there is some doubt, have been excluded as have the *A. erioloba* E. Mey \times *A. haematoxylon* Willd. hybrid and other hybrids, *A. purpurea* Bolle, *A. mauroceana* DC. and *A. calli-coma* Meisn., which are names of uncertain application, and *A. sp.* near *senegal*, *A. sp.* near *somalensis* and others which are insufficiently known. The 115 species recognized by no means represent the final total number of species for the continent but this figure does serve as a basis, imperfect as it is, for an analysis of the African species. Because of the variation in the size of individual countries and because no country has species evenly distributed throughout it,

the number of species per country is of somewhat limited value alone. Furthermore, the distribution of species within countries in tropical east, south-east and southern Africa is far better documented than in a number of countries in other areas of the continent. However, despite these limitations and, although perhaps the figures provided in Table 1 are incorrect in some details and likely to need alteration in the light of additional information, it is believed that the overall patterns that emerge are sufficiently accurate to be of value.

Examination of Table 1 reveals, not surprisingly, that the highest concentrations of species occur in countries in tropical north-east, east and south-east Africa. The figures suggest that there is a tendency in most countries in tropical north-east, east, south-east, southern and south-west Africa for subgenus *Acacia* to be proportionately better represented than subgenus *Aculeiferum*, although Mozambique is an obvious exception to this generalization, while in Zaire and in countries to the north-west subgenus *Aculeiferum* is often numerically as important as or

TABLE 1.—The representation of the *Acacia* species within each African country

Country	No. of species in subgenus <i>Acacia</i>	No. of species in subgenus <i>Aculeiferum</i>	Total no. of species
Morocco	2	0	2
Algeria	5	1	6
Tunisia	0	0	0
Libya	3	0	3
Egypt	7	3	10
Western Sahara	1	0	1
Mauritania	3	2	5
Senegal	5	4	9
Gambia	2	3	5
Guinea-Bissau	3	2	5
Guinea Republic	1	2	3
Sierra Leone	0	4	4
Mali	7	7	14
Liberia	0	2	2
Ivory Coast	5	8	13
Ghana	6	6	12
Togo	3	1	4
Benin (Dahomey)	3	5	8
Upper Volta	4	3	7
Nigeria	8	10	18
Niger	6	6	12
Cameroon (British)	3	3	6
Cameroon (French)	2	3	5
Chad	3	2	5
Central African Republic	4	1	5
Sudan	19	12	31
Ethiopia	28	43	15
Somalia	18	14	32
Equatorial Guinea	0	1	1
Gabon	0	1	1
Congo Brazzaville	1	1	2
Cabinda	0	1	1
Zaire	11	13	24
Rwanda	6	3	9
Burundi	4	2	6
Uganda	18	9	27
Kenya	27	15	42
Tanzania	31	19	50
Angola	14	11	25
South West Africa/Namibia	14	9	23
Zambia	16	13	29
Malawi	13	8	21
Mozambique	20	20	40
Botswana	18	12	30
Zimbabwe	22	16	38
South Africa:			
Transvaal	21	14	35
Orange Free State	4	2	6
Natal	13	8	21
Cape Province	8	3	11
Swaziland	12	6	18
Lesotho	1	0	1
Transkei	2	3	5

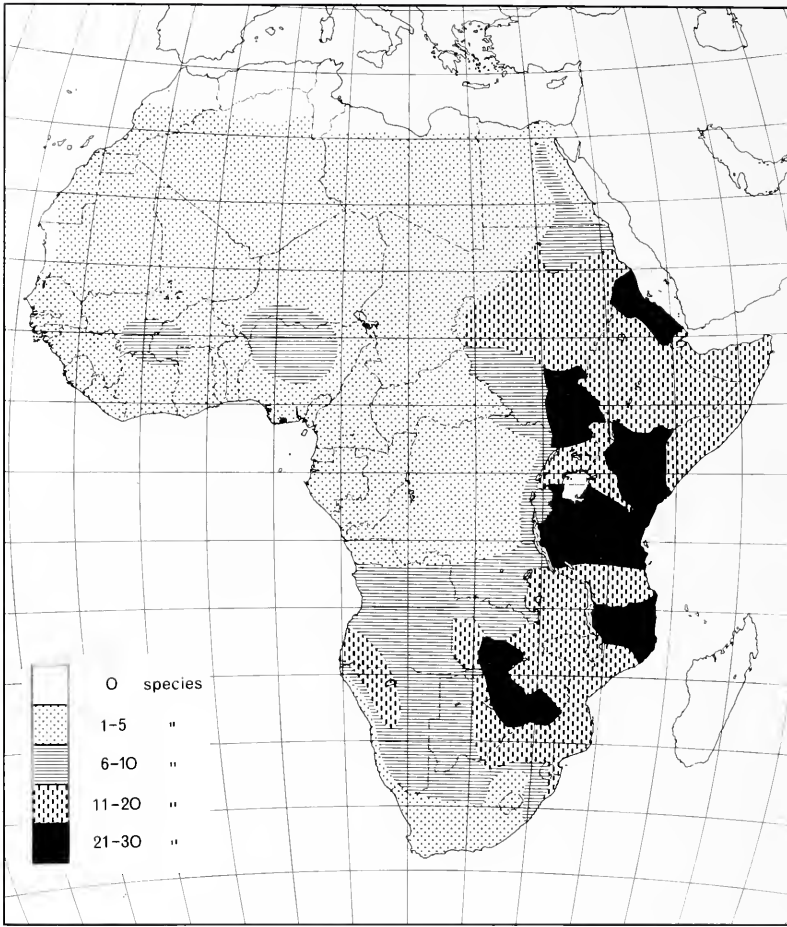


FIG. 4.—The general distribution of the *Acacia* species in Africa and an indication of the concentration of species over the distributional range of the genus.

even proportionately more important than subgenus *Acacia* although once again there are a number of exceptions. This apparent proportional preponderance of subgenus *Aculeiferum* in Zaire and parts of tropical west Africa may possibly be due to the presence of extensive forested areas which climbing species in subgenus *Aculeiferum* have been able to colonize but from which subgenus *Acacia* has been largely excluded.

The general distribution of the genus *Acacia* in Africa and an indication of the concentration of species over the distributional range is shown in Fig. 4. As in the case of the information in Table 1, Fig. 4 is more accurate in some areas than in others and this uneven treatment is a reflection of the uneven knowledge of the genus over its range of distribution.

The genus is widely distributed over the continent being absent only from the extreme northern portion of north Africa, part of Mauritania and western Sahara in West Africa, the vicinity of Cape Town in the extreme south-western tip of the continent and from parts of the west coast in South West Africa.* Tunisia is the only political entity on the continent in which no indigenous *Acacia* species are found. The greatest concentration of species occurs in tropical east and south-east Africa and, as one would expect, fewest species occur in desert regions to the north and south and in the rainforest areas, particularly in

Zaire and in parts of tropical west Africa. Although the genus is so widespread and forms such a conspicuous feature of the landscape over much of the continent, the number of species found in Africa is lower than one might expect and represents less than one-sixth of the number of species found in Australia.

Having noted the distribution of the genus as a whole in Africa, the distributions of subgenus *Acacia* and of subgenus *Aculeiferum* are now examined (see Figs 5 & 6). Of the 115 species accepted for Africa, 52 belong to subgenus *Aculeiferum* and 63 to subgenus *Acacia*.

It is at once apparent that there are significant differences in the distributional ranges of the two subgenera. Subgenus *Acacia* extends far further north than subgenus *Aculeiferum* being found for the most part as far north as 30° N latitude except in Algeria and Morocco where the subgenus occurs even further north and in the Nile valley in Egypt where a species occurs in the Nile delta. Subgenus *Aculeiferum*, on the other hand, does not occur much north of 20° N latitude except in Egypt and more particularly in the Nile Valley. In the extreme south of the continent subgenus *Acacia* occurs to within 100 km of Cape Town while subgenus *Aculeiferum* has not succeeded in penetrating the south-west tip of the Cape Province and is also absent from the high country in Lesotho and the eastern Orange Free State. Both subgenera are absent from parts of the west coast of

*Namibia

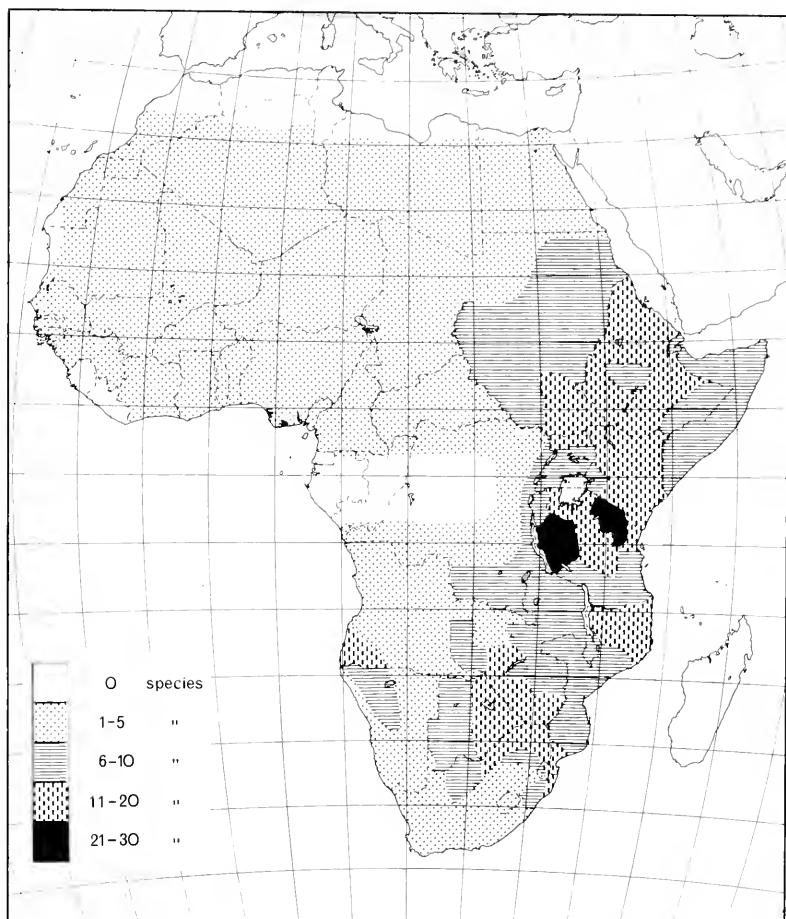


FIG. 5.—The general distribution of subgenus *Acacia* in Africa and an indication of the concentration of species over the distributional range of the subgenus.

South West Africa bordering the Atlantic Ocean and from part of western Mauritania. Although the range of distribution of some individual species in subgenus *Aculeiferum*, for example *A. ataxacantha*, is almost as extensive as that of some of the more widespread species in subgenus *Acacia* such as *A. sieberana* DC. (see Fig. 7), the total distributional range of subgenus *Acacia* greatly exceeds that of subgenus *Aculeiferum*. The fact that subgenus *Acacia* enjoys a wider range of distribution on the continent than does subgenus *Aculeiferum* suggests that the former has been able to occupy habitats, particularly the harsh habitats in the central Sahara and the high country of Lesotho, from which subgenus *Aculeiferum* has been excluded. Most (? all) members of subgenus *Acacia* are polyploid while those of subgenus *Aculeiferum* are diploid and the possibility exists that polyploidy has conferred greater genetic plasticity on subgenus *Acacia* which has enabled members of the subgenus to successfully occupy a greater diversity of habitats. On the other hand, however, some of the climbing species in subgenus *Aculeiferum* have been successful in the forested areas of the continent, particularly in Zaire and in parts of tropical west Africa, in which subgenus *Acacia* is not represented. It would appear that the climbing habit, which is unknown in subgenus *Acacia*, has enabled members of subgenus *Aculeiferum* to exploit situations in forested areas where light penetrates to the ground. Subgenus *Acacia* is apparently absent from Liberia, Sierra

Leone, Gabon, Equatorial Guinea and the densely forested areas in Zaire.

Apart from the exceptions noted above, the distribution of species in subgenera *Acacia* and *Aculeiferum* over the remainder of the continent is roughly similar although the number of species in individual areas within each subgenus varies. The highest concentration of species in both subgenera occurs in tropical east and south-east Africa.

The pattern of distribution exhibited by *A. sieberana* (see Fig. 7) is fairly representative of that shown by a number of widespread species in both subgenera, extending from Senegal in the west to the Sudan or Ethiopia in the north-east and down tropical east Africa through Kenya, Uganda and Tanzania skirting around the forested areas of central Zaire with one arm swinging westwards through Zambia, south-east Zaire, Zimbabwe and Botswana to Angola and northern South West Africa and another arm continuing southwards through Mozambique, the Transvaal and Swaziland into Natal. The two arms of distribution approximate roughly to the temperature and rainfall belts.

The distribution of species within some of the individual countries is now considered in more detail.

Two species, both members of subgenus *Acacia*, have been recorded from southern Morocco in the extreme north-west of the continent, namely, *A.*

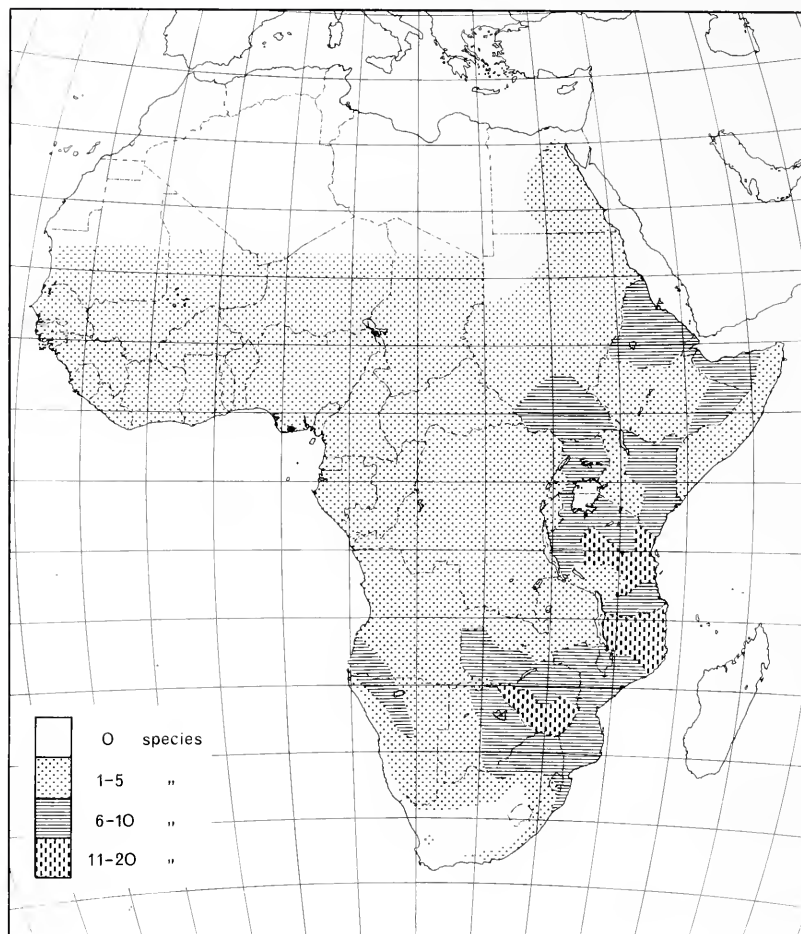


FIG. 6.—The general distribution of subgenus *Aculeiferum* in Africa and an indication of the concentration of species over the distributional range of the subgenus.

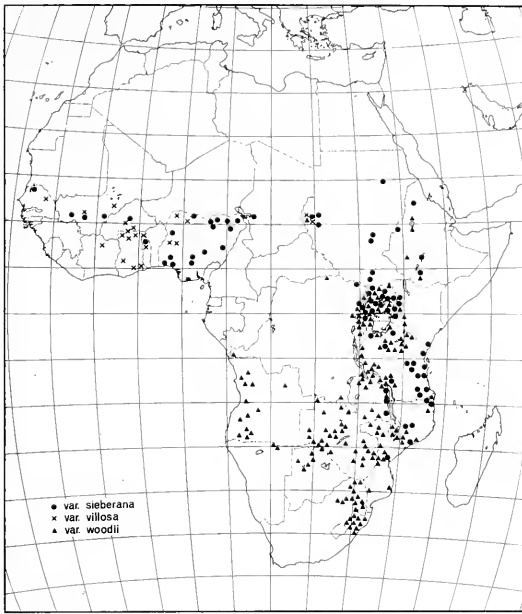
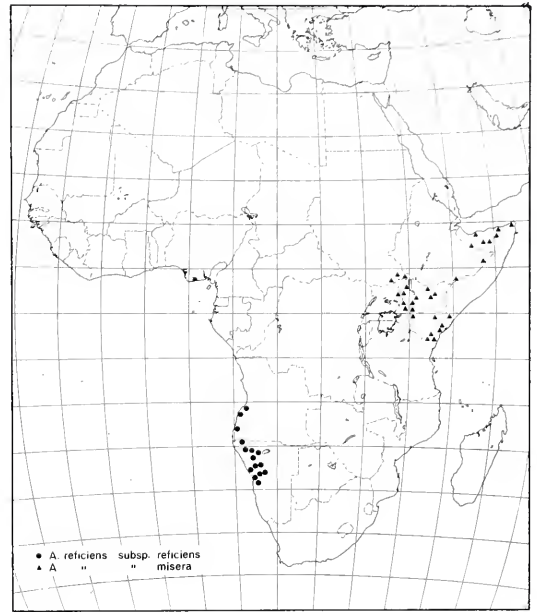
seyal Del. and *A. gummifera* Willd. While *A. seyal* is widely distributed in Africa, *A. gummifera* is endemic in Morocco and has a very restricted distribution within the country. Morocco is the only country in north or west Africa, which has an endemic *Acacia* species. Although *A. gummifera* is adapted to a Mediterranean climate Quezel (1979) considered it to be of tropical origin and represent a 'differentiated vestige' which has been 'in situ' since the Pleistocene. *A. gummifera* is most closely allied to the tropical and widespread *A. nilotica* (L.) Willd. ex Del. and possibly arose from *A. nilotica* stock that became isolated as a result of climatic vicissitudes which have largely eliminated the tropical element from Mediterranean Africa.

The northern limit of *Acacia* in Libya and Algeria corresponds with the northern limit of distribution of *A. tortilis* (Forssk.) Hayne subsp. *raddiana* (Savi) Brenan. The Sahara is inhabited by very few *Acacia* species and, according to Quezel (1979), the evidence indicates that they penetrated into the Sahara only at the end of the last pluvial, probably after several previous phases of extension, but did not reach the Mediterranean regions because of their thermal demands.

In Egypt most species occur in a zone along the Nile River with fewer species occurring in the adjacent desert areas. *A. nilotica* follows the course of the Nile into the delta itself.

Thirty-one species, none of which is endemic, occur in the Sudan. The highest concentration of species occurs in the south-east where the territory adjoins Ethiopia, Kenya and Uganda, and the numbers decrease quite sharply in the south-west, central and northern areas. The genus is very poorly represented in the north-western portion of the country.

Ethiopia, with its diversified topography, has 43 species, the second highest number among the African countries. In addition to being rich in species, Ethiopia is an important area of speciation for *Acacia*, each subgenus having three endemic species. Among the endemics are *A. walwalensis* Gilliland and *A. pseudonigrescens* Brenan & J. H. Ross, two very distinctive species confined to the Ogaden. The highest number of species occurs in the north-east adjacent to the Red Sea, but the Harar Province and Ogaden are also rich in species. *A. reficiens* Wawra has a very disjunct distribution (see Fig. 8): subsp. *misera* (Vatke) Brenan occurring in north-eastern Uganda, south-eastern Sudan, Kenya, eastern Ethiopia and Somalia and subsp. *reficiens* occurring in south-western Angola and northern South West Africa, the species providing a good example of the well known distributional discontinuity between the more arid areas of South West Africa and the north-east Horn of Africa. Verdcourt (1969) and De Winter (1971) provided examples of disjunctions in other

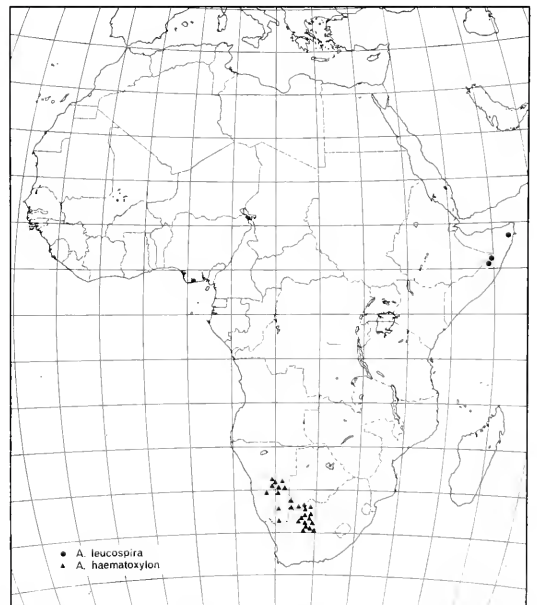
FIG. 7.—The known distribution of *Acacia sieberana*.FIG. 8.—The known distribution of *Acacia reficiens*.

genera and families which furnish evidence of a former arid corridor across the continent from the north-east to the south-west. Conditions for direct migration were probably best when arid phases of the Pleistocene were at a maximum and distances between the arid zones were least or possibly when a continuous arid belt extended across Africa from the north-east to the south-east. The distribution of *A. stuhlmannii* Taub. provides a less extreme example of the disjunct distribution illustrated by *A. reficiens*, while some species have a more or less continuous distribution from the north-east to the south-west.

Somalia has a remarkable flora and the *Acacia* species are no exception. Although only 32 *Acacia* species have been recorded from Somalia, nine are endemic (seven in subgenus *Aculeiferum* and two in subgenus *Acacia*). Somalia has been an important centre of speciation in the '*A. senegal* (L.) Willd. complex' where six very distinctive endemic taxa have arisen, namely, *A. ankokib* Chiov., *A. caraniana* Chiov., *A. cheilanthifolia* Chiov., *A. ogadensis* Chiov., *A. somalensis* Vatke and *A. sp.* near *A. somalensis*. *A. zizyphispina* Chiov., another member of the '*A. senegal* complex', although not endemic in Somalia itself, has a very restricted distribution in southern Somalia and in the Ogaden in Ethiopia. *A. bricchettiana* Chiov. (subgenus *Acacia*) is similarly confined to the Ogaden region in Somalia and Ethiopia. Several other species, for example *A. condyoclada* Chiov., yet another member of the '*A. senegal* complex', and *A. edgeworthii* T. Anders. (subgenus *Acacia*) are confined to Ethiopia, Somalia and the Northern Frontier Province of Kenya (*A. edgeworthii* also occurs on Socotra), while *A. turnbulliana* Brenan is confined to Somalia and the Northern Frontier Province of Kenya. *A. leucospira* Brenan, another endemic, is a very distinctive species with minute laterally compressed leaflets which are reminiscent of those of *A. haematoxylon* in southern Africa (see Fig. 9). Small laterally compressed leaflets are unknown elsewhere amongst the African species but *A. leucospira* and *A. haematoxylon* are

not closely related. The Horn of Africa has been an important centre of speciation in *Acacia*.

Kenya, with 42 species, has only one endemic species, namely, *A. thomasii* Harms, a member of the '*A. senegal* complex', while *A. paolii* Chiov. subsp. *paucijuga* Brenan is endemic in the north-west of the country. The poverty of endemism in Kenya is in marked contrast to Tanzania. The distribution of *Acacia* in Kenya according to the provinces recognized in the Flora of Tropical East Africa is as follows: K1, Northern Frontier : 26 species; K2,

FIG. 9.—The known distributions of *Acacia leucospira* and *A. haematoxylon*.

Turkana : 18 species; K3, Rift Valley : 15 species; K4, Central : 23 species; K5, Nyanza : 12 species; K6, Masai : 19 species; K7, Coast : 23 species. These figures illustrate the richness of the Northern Frontier Province, mainly because of the presence there of the Somali element, the central and Coastal Provinces, and the relative poverty of western Kenya.

Uganda, with 27 species, has far fewer species than either Kenya or Tanzania and the relative poverty evident in western Kenya is again evident over much of Uganda. The distribution of *Acacia* in Uganda according to the provinces recognized in the Flora of Tropical East Africa is as follows: U1, Northern : 24 species; U2, Western : 11 species; U3, Eastern : 16 species; U4, Buganda : 13 species. The Northern Province which is well watered in the west is by far the richest province.

Tanzania, with 50 species, has significantly more species than any other country and both subgenera *Acacia* and *Aculeiferum* are best represented in Tanzania. In addition, ten of the species, three in subgenus *Aculeiferum* and seven in subgenus *Acacia*, are endemic in Tanzania. The distribution of *Acacia* in Tanzania according to the provinces in the Flora of Tropical East Africa is as follows: T1, Lake : 23 species; T2, Northern : 28 species; T3, Tanga : 28 species; T4, Western : 29 species; T5, Central : 27 species; T6, Eastern : 21 species; T7, Southern Highlands : 14 species; T8, Southern : 16 species. These figures illustrate the relative poverty of *Acacia* species in the Southern Highlands and Southern Province in contrast to the remainder of the country over which the species are fairly evenly spread. Tanzania has been an important centre of speciation in the '*A. drepanolobium* Harms ex Sjöstedt complex', a complex of species with characteristically enlarged stipular spines ('ant-galls'). In addition to the widespread *A. drepanolobium*, six species with enlarged stipular spines, namely *A. bullockii* Brenan, *A. burtii* Bak. f., *A. erythrophloea* Brenan, *A. malaccephala* Harms, *A. inbuluensis* Brenan and *A. pseudofistula* Harms, are endemic in Tanzania and two of them, *A. bullockii* and *A. erythrophloea*, are endemic in the Western Province. The Western Province is outstanding on account of the number of endemics found within it: seven of the ten endemic *Acacia* species in Tanzania are found within the Western Province although only the above two species are confined to it. *A. taylorii* Brenan & Exell, a member of the '*A. pennata* complex' with scattered recurved prickles, is endemic along the coast in the Southern Province towards the Mozambique border, *A. tephrodermis* Brenan in the same complex is endemic in the Eastern Province and *A. latistipulata* Harms, yet another member of the complex, occurs from central Tanzania to central Mozambique. *A. ancistroclada* Brenan, although not endemic in Tanzania itself, has a restricted distribution in north-east Tanzania and south-east Kenya. *A. stuhlmannii* has a discontinuous distribution being recorded from Ethiopia, Somalia, Kenya and northern and central Tanzania in the north and from Zimbabwe, Botswana and the Transvaal in the south.

Zaire illustrates very well the point made earlier that *Acacia* species are not spread uniformly throughout a country. Twenty-four species are recorded from Zaire but the great majority are confined to the mainly wooded grasslands of the Ubangi-Uele, Lac Albert, Lacs Edouard et Kivu, Bas-Katanga and Haut-Katanga regions (phytogeographical regions used in Flore du Congo, du Rwanda et du

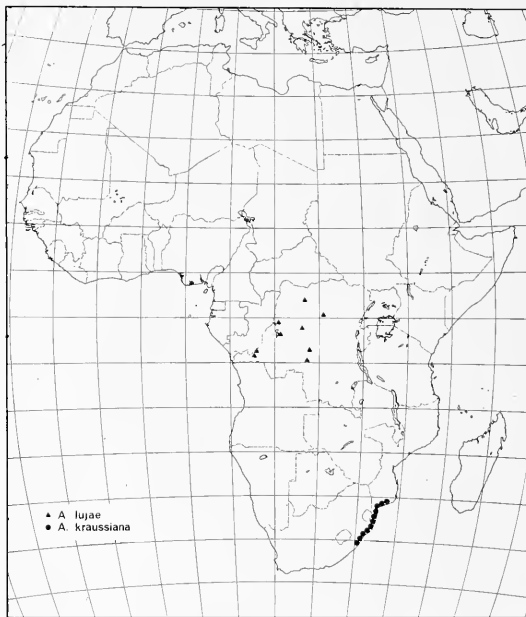


FIG. 10.—The known distributions of *Acacia lujae* and *A. kraussiana*.

Burundi) in the north, north-east, east and south-east respectively. Only four species, *A. kamerunensis* Gandoger, *A. ciliolata* Brenan & Exell, *A. pentagona* (Schumacher) Hook. f. and *A. lujae*, all climbing species in subgenus *Aculeiferum*, occur in the Forester Central region. *A. lujae* is the only endemic *Acacia* species in Zaire. *A. lujae* seems more closely related to *A. kraussiana*, which is endemic along the coast in southern Mozambique and Natal and from which it is separated by a wide interval, than it is to any members of the '*A. pennata* complex' (see Fig. 10).

Acacia is very poorly represented in Congo Brazzaville, Cabinda, Gabon and Equatorial Guinea, the sole member of the genus in each of the last three countries being a climbing member of subgenus *Aculeiferum*. In contrast to tropical east Africa, the genus is generally poorly represented in tropical west Africa.

Mozambique, with 40 species, has only one endemic species, namely *A. torrei* Brenan, a member of the complex with glandular glutinous pods which is centred on the Transvaal in South Africa. Although not endemic in Mozambique itself, a number of other species occurring in Mozambique have restricted distributions outside the country. *A. latistipulata* and *A. kraussiana* have already been alluded to but another example is *A. eriocarpa* Brenan whose distribution extends from Mozambique into eastern Zambia and central and western Zimbabwe. It is not clear whether or not *A. rosvumae* Oliv. occurs in Mozambique as there are no definite records of the species from the territory. The type locality of *A. rosvumae* was given as 'Rovuma Bay' without any indication of whether it was collected from the north or south side, crucial information as the Rovuma river forms the boundary between Mozambique and Tanzania. The absence of any definite records of the species from Mozambique suggests that it does not occur in the territory. The distribution of *Acacia* in Mozambique according to the provinces recognized in Flora

Zambesiaca is as follows: Niassa : 22 species; Zambezia : 16 species; Tete : 21 species; Manica e Sofala : 20 species; Sul do Save : 17 species; Lourenco Marques : 23 species. The highest numbers of species occur in the extreme north and south of the country and in the Tete province.

Of the 38 species occurring in Zimbabwe only *A. chariessa* Milne-Redhead, which is almost always found on serpentine soils, is endemic. Vegetation growing on serpentine soils often shows stunting or depauperation (Wild, 1974) and *A. chariessa* often looks superficially like a diminutive form of the widespread *A. ataxacantha*, although differing from it in several significant respects. The distribution of *Acacia* species in Zimbabwe according to the provinces recognized in Flora Zambesiaca is as follows: North : 19 species; East : 17 species; Central : 15 species; West : 27 species; South : 27 species. The greatest numbers of species occur in the south and west, the numbers there being increased by the presence of several members of the complex with glandular glutinous pods, namely *A. borleae* Burtt Davy, *A. exuvialis* Verdoorn, *A. nebrownii* Burtt Davy and *A. permixta* Burtt Davy, and species such as *A. erioloba* E. Mey. and *A. luederitzii* Engl. which favour dry woodland and often occur on the Kalahari sands.

No endemic species occur in Zambia, Malawi or Botswana. The southern province of Zambia, which to some extent represents a northern extension of the western province of Zimbabwe, is by far the richest province, while the western province with only six species is the poorest. The north and south-east provinces of Botswana each have 23 species but the genus is poorly represented in the arid south-west province where only 9 species occur.

The highest number of species in South West Africa occurs in the north-west and the highest number in Angola in the south-west in the Huila, Mossamedes and Benguela Districts. Two of the 23 species in South West Africa, namely *A. montis-usti* Merxm. & Schreiber and *A. robynsiana* Merxm. & Schreiber, are endemic in the north-west and two of the 25 species in Angola, *A. antunesii* Harms and *A. quintanilhae* Torre, are endemic in the south-west. While both endemics in South West Africa are members of subgenus *Aculeiferum*, the endemics in Angola both belong to subgenus *Acacia*. In addition to these endemics with narrow distributional ranges, *A. hebeclada* DC. subsp. *tristis* Schreiber is confined to much the same area in north-western South West Africa and south-western Angola. Reference has already been made to the discontinuous distribution shown by *A. reficiens* but *A. mellifera* (Vahl) Benth. subsp. *inellifera* also has a disjunct distribution occurring in northern South West Africa and south-

western Angola (Mossamedes and Benguela Districts) in the south and in Tanzania and territories to the north. The number of *Acacia* species in Angola falls away from the south-west to the north and east particularly towards the forested areas in the north although *A. welwitschii* Oliv. subsp. *welwitschii* is endemic in northern Angola. South-western Angola and north-western South West Africa (with the exception of a narrow strip along the coast from which the genus is absent) appear to be one of the more important centres of speciation in *Acacia* in southern tropical Africa.

The southern limit of distribution of the genus in Africa occurs in the Cape Province in South Africa and, as one would expect, the number of species in South Africa declines rapidly to the south particularly along the east coast. Twenty-one species, all of which occur in Zululand and Tongaland in the north, are recorded from Natal. However, impoverishment to the south in Natal is fairly rapid as a number of species reach their southern limit of distribution in Natal. Of the twenty-one species which occur in Tongaland and Zululand in the north, only thirteen occur south of the Tugela River, and of these thirteen only five species extend south of the Umtamvuna river into Transkei. The number of species in Natal also falls away fairly rapidly with increasing altitude towards the interior and the widespread *A. karroo* Hayne is the only species in Lesotho. The majority of species in Swaziland occur in the lowveld in the east with fewer species in the higher areas. The Transvaal, with 35 species, has the highest number of species of all of the provinces in South Africa. Once again, the majority of species occur in the lowveld in the east and in the north with fewer species occurring in the highveld region with its colder winters. A number of species favouring sandy soils occur in the western portion of the province. The complex of species with glandular glutinous pods appears to be centred in the Transvaal where six of the seven species within the complex are found. Only *A. torrei*, which is endemic in Mozambique, is absent. Eleven species occur in the Cape Province one of which, *A. redacta* J. H. Ross, is endemic. *A. redacta* is an extremely interesting species in many respects showing no close affinity with any other species and the possibility exists that it is not an *Acacia* at all but is referable to a new monotypic genus. Although not confined to the northern Cape, *A. haematoxylon* has a restricted distribution outside the province occurring in the extreme south-west of Botswana and in the eastern portion of South West Africa, while the *A. erioloba* × *A. haematoxylon* hybrid is confined to the northern Cape. *Acacia* is best represented in the northern Cape on the Kalahari sands and only *A. karroo* is common over much of the southern and western portion of the province.

TABLE 2.—The countries within which endemic *Acacia* species occur and the number of endemic species within each country

Country	No. of species in subgenus <i>Acacia</i>	No. of species in subgenus <i>Aculeiferum</i>	Total no. of species
Morocco	1	0	1
Ethiopia	3	3	6
Somalia	2	7	9
Zaire	0	1	1
Kenya	0	1	1
Tanzania	7	3	10
Angola	2	0	2
South West Africa/Namibia	0	2	2
Mozambique	1	0	1
Zimbabwe	0	1	1
South Africa-Cape Province	1	0	1

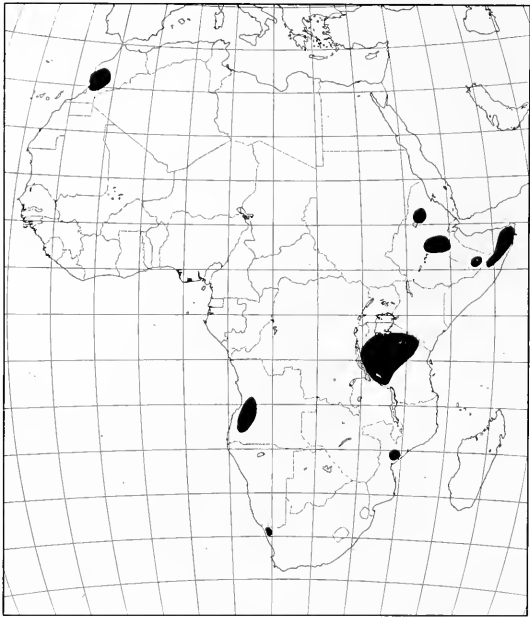


FIG. 11.—The distribution of the narrow endemics within subgenus *Acacia* referred to in Table 2.

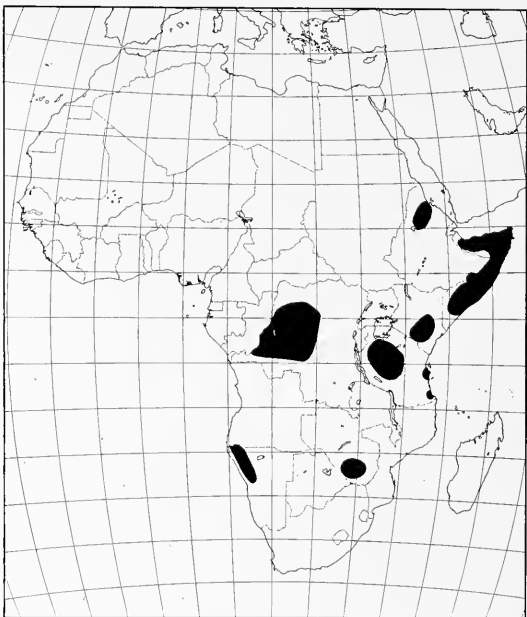


FIG. 12.—The distribution of the narrow endemics within subgenus *Aculeiferum* referred to in Table 2.

The countries in which endemic species occur and the number of endemics recorded within each are given in Table 2.

Because of the variation in the size of individual countries and because no country has an even spread of endemism, the number of endemic species per country is of limited value alone. For example, Tanzania with ten endemic species out of a total of fifty species has a greater number of endemics than Somalia with nine endemics out of a total of 32 species, but the proportion of endemics in Somalia is greater. However, despite the limitations, the information in Table 2 is nevertheless fairly instructive.

Table 2 shows that the highest numbers of endemic species occur in Tanzania, Somalia and Ethiopia in tropical east and north-east Africa. Interestingly, the highest number of endemic species in subgenus *Acacia* occur in Tanzania while the highest number of endemics in subgenus *Aculeiferum* occur in Somalia. Morocco is the only country in north or west Africa which has an endemic species. Although the Sudan has one more species than Somalia, the Sudan has no endemic species while Somalia has nine, and Ethiopia with one more species than Kenya has six endemics and Kenya only one. The distribution of the narrow endemics within each subgenus referred to in Table 2 are illustrated in Figs 11 and 12.

The endemism in the genus *Acacia* in Africa is shown in Table 3.

The high proportion of species endemic in one country in contrast to the much lower figures for those species endemic in two or three countries emphasizes the prevalence of species with narrow ranges.

It is instructive to briefly compare the distribution of the African *Acacia* species in Fig. 4 with the phytogeographical regions of Africa (see Fig. 13). Fig. 13 is a slightly simplified version adapted from the scheme accepted by Brennan (1979) which was itself based on the earlier works of Wickens (1976), White (1965) and Chapman & White (1970). Wickens (*l.c.*) recognized eight Regions in Africa, three of which were themselves divided into domains.

The Sudano-Zambezian Region, which is characterized by a strong seasonal climate, corresponds to the tropical savanna and is by far the largest Region in Africa extending north and south of the equator but physically continuous by a relatively narrow connection in east Africa. To the north it is bounded by the deserts and semideserts of the Sahara, in the centre it circumscribes the limits of the forests of the Guineo-Congo Region, and in the south it extends to the deserts and semideserts of the Karoo Namib Region and the Cape Region. As is to be expected, the majority of *Acacia* species occur within this region.

1. The Sahelian Domain extends from Mauritania and Senegal on the Atlantic in the west to the Red Sea

TABLE 3.—Endemism in the genus *Acacia* in Africa

Region	No. of species	% of the total
Endemic in 1 country	35	30.43
Endemic in 2 countries	10	8.69
Endemic in 3 countries	8	6.95
Occurs in more than 3 countries but endemic in continental Africa	46	40.00
Distribution extends beyond the confines of continental Africa	16	13.92

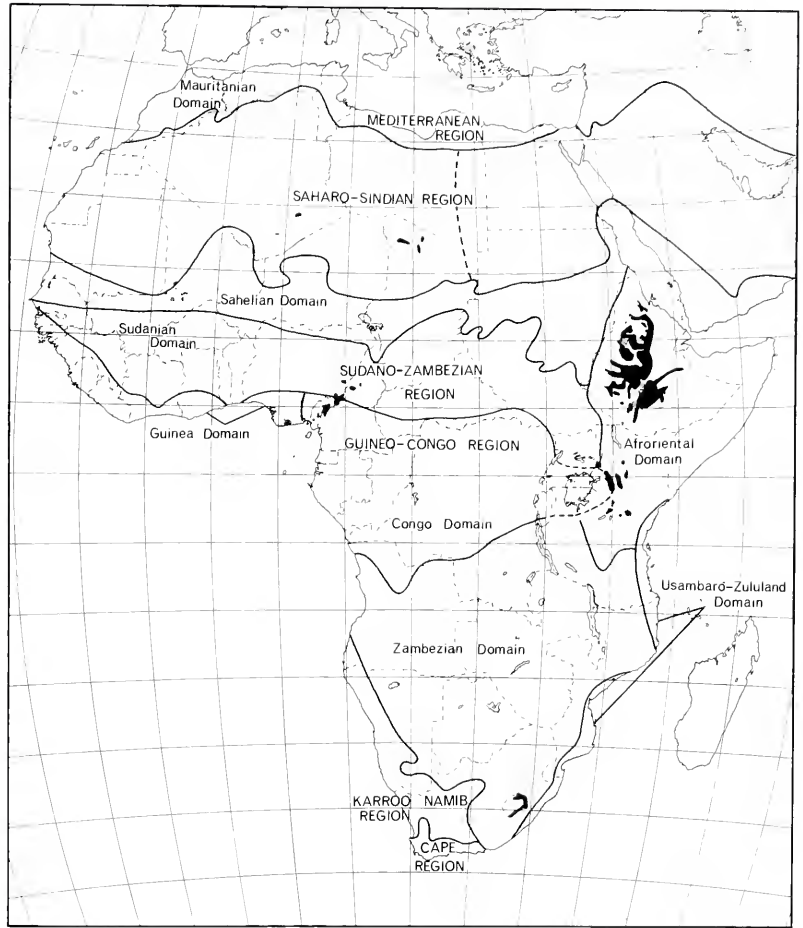


FIG. 13.—The phytogeographical regions and domains of Africa (After Brenan, 1979).

coast of the Sudan in the east forming a narrow belt bounded on the north by the Saharo-Sindian Region. The domain thus separates the desert flora of the Sahara from the deciduous woodlands and other communities of the Sudanian domain. The southern boundary of the Sahelian domain largely corresponds to the southernmost extent of the Pleistocene sand invasion (Wickens, 1976). A number of widespread species such as *A. tortilis*, *A. seyal*, *A. ehrenbergiana* Hayne and *A. nubica* Benth. are characteristic of this domain but no endemic species occur within it.

2. The Sudanian Domain extends from Senegal to the eastern border of the Sudan and forms a wide belt bounded to the north by the former domain and to the south by the Guineo-Congo Region. *Acacia* is well represented within the deciduous woodlands and savannas of this domain, most of the species occurring within it being fairly widespread in tropical Africa and some extending to Asia. The Sudanian domain is much drier than the Zambezan domain and its greater aridity has been largely responsible for the marked differences between the two domains, the impoverishment of the flora of the former, and the asymmetrical distribution of savanna-type vegetation north and south of the equator (White, 1965).

3. The Afro-oriental Domain, which includes the 'Horn of Africa' and extends southwards into Tanzania, contains by far the greatest number of *Acacia* species and the greatest number of endemics illustra-

ting the importance of this area for speciation in *Acacia*.

4. The Zambezan Domain consists of the remainder of the Sudano-Zambezan Region lying to the south of the Afro-oriental domain and is also rich in species and endemics. The main centre of endemism within this domain is north-western Tanzania while a secondary centre occurs in the area occupied by Zimbabwe, Botswana, south-western Mozambique and the northern Transvaal.

The Guineo-Congo Region represents the main evergreen or partly evergreen forests of Africa extending from Senegal in the west, southwards to Angola and eastwards to Ruwenzori. The climate is characteristically one of high even temperatures and rainfall more or less throughout the year. As is to be expected of a genus which is intolerant of low light intensities, *Acacia* species are not very well represented within this region tending to occupy forest margins or clearings where openings in the canopy permit light to penetrate. The climbing species in subgenus *Aculeiferum* tend to be better represented in the forested region than the trees and shrubs of subgenus *Acacia*. Three domains are recognized within the region, namely, the Guinea, Congo and Usambaro-Zululand domains. The Usambaro-Zululand domain, which consists of the scattered relics of rainforest along or near the east coast of Africa, has the highest number of species of the three domains

and five endemics, all members of subgenus *Aculeiferum*, occur within it. One of the endemics, *A. kraussiana* occurring in Natal and southern Mozambique, seems closely related to *A. lujae*, the only endemic species in the Congo domain. Neither the Congo nor the Guinea domain is very rich in *Acacia* species which is not surprising as these are the best forested domains in the region.

Acacia is absent from the Afromontane Region which corresponds to the Montane Forest and Ericaceous belts of the tropical mountain regions and from the Afroalpine Region which is the zone above the Ericaceous belt of the former Region.

The Saharo-Sindian Region is a region of desert and semidesert to the north of the Sahelian domain extending from western Sahara, Mauritania and southern Morocco eastwards across Sinai to India. The climate is characterized by high temperatures, often with extreme diurnal fluctuations, and low and often irregular rainfall. A few widespread species such as *A. tortilis*, *A. seyal*, *A. ehrenbergiana* and *A. nilotica* occur in parts of the region and there is a local concentration of species in the Nile valley. According to Quezel (1979), the Sahelian species penetrated into the Sahara only at the end of the last pluvial but did not reach the Mediterranean Region because of their thermal demands.

The Mediterranean Region, characterized by hot dry summers with mild winters during which much of the rain falls, is the northernmost fringe of Africa bounded in the south by the Saharo-Sindian Region and in the north by the Mediterranean. *A. gummifera* is endemic in Morocco and a few species occur in the Nile valley but, apart from these, *A. tortilis* is possibly the only other species to occur in parts of the Region.

The Cape Region, dealt with in detail by Goldblatt (1979), occupies the extreme south-west of the continent and has a Mediterranean type climate in which the genus *Acacia* is unimportant and represented by only a few species. *A. karroo* and *A. caffra* are the most widespread species within the Region.

The Karoo-Namib Region occupies the interior of the Cape Province, the western portion of South West Africa and extends into south-western Angola. Except for the southern portion of the Cape Province and isolated pockets along the Atlantic coast, *Acacia* is fairly well represented throughout the area, particularly in northern South West Africa and south-western Angola. *A. erioloba*, *A. hereroensis* Engl., *A. karroo*, *A. tortilis* and *A. mellifera* are characteristic of many areas. Four endemic species occur in northern South West Africa and south-western Angola, an important local centre of speciation in *Acacia*.

RELATIONSHIP BETWEEN THE AFRICAN AND AMERICAN SPECIES

The currently accepted sequence of events which marked the beginning of the fragmentation of West Gondwanaland and the separation of the African and South American plates was outlined by Raven & Axelrod (1974) and is summarized briefly here. Separation of the African and South American plates started about 127 million years ago with the final marine connection between the North and South Atlantic occurring about 100 million years ago. The two continents remained in close proximity with only a narrow strait separating the present Gabon from north-eastern Brazil for another 10 million years. By

the end of the Cretaceous, about 65 million years ago, the two continents are thought to have been separated at their closest points by about 800 km although they are said to have been linked by numerous volcanic islands. South America moved away from Africa and gradually converged with North America becoming equidistant between the two early in the Eocene about 50 million years ago. South America subsequently became more isolated from Africa and closer to North America until a direct land connection between North and South America occurred in the Pliocene 7–5 million years ago. This sets the background against which the African and American species must be seen.

There is no evidence and it seems unlikely that *Acacia* or its prototype had differentiated when Africa separated from South America about 100 million years ago, and it is not clear whether the genus crossed the Atlantic in the late Cretaceous about 65 million years ago (by which time the three subfamilies of Leguminosae are known to have been differentiated) when the two continents were separated but thought to have been linked by numerous volcanic islands, or whether the genus was carried over the Atlantic in Paleocene or Eocene time. From what is known or can be inferred about its history and present distribution patterns Raven & Axelrod (1974) presume that Mimosoideae migrated between Africa and South America during or prior to the Paleocene when the Atlantic was much narrower than at present, while Thorne (1978) is of the opinion that migration could have occurred in the late Cretaceous, Paleocene or Eocene. The evidence suggests that only limited migration occurred between these continents after the Paleocene.

Both subgenera *Acacia* and *Aculeiferum* are present in Africa and in America. However, the representation of subgenus *Aculeiferum* in each continent is different: sections *Monacantha* and *Aculeiferum* occurring in Africa and sections *Monacantha* and *Filicinae* in America, i.e. *Filicinae* is absent from Africa and *Aculeiferum* is absent from America. The position of *A. willardiana* Rose, which has a horizontally flattened petiole and is endemic to the west coast of North America (Mexico), is uncertain and opinions differ as to whether it should be referred to subgenus *Aculeiferum* or subgenus *Heterophyllum*. Vassal & Guinet (1972) included *A. willardiana* in subgenus *Heterophyllum* while Pedley (1975) argued that the species could be accommodated without difficulty in subgenus *Aculeiferum* as it showed relationships to American species of the subgenus. In support of their earlier contention that *A. willardiana* belonged to subgenus *Heterophyllum* Guinet & Vassal (1978) pointed out that the seed of *A. willardiana* contains the amino-acid 'willardine' (Gmelin, 1959) which has also been recorded from the Australian species *A. podalyriifolia* A. Cunn. ex G. Don and *A. dealbata* Link both of which are members of subgenus *Heterophyllum*. However, 'willardine' is also present in the Asian *A. modesta* Wall., a member of subgenus *Aculeiferum* (Evans *et al.*, 1977). The available evidence suggests that *A. willardiana* is in fact referable to subgenus *Aculeiferum*.

No species in section *Monacantha* is common to Africa and the Americas although some tropical species on each continent show close similarities, for example, *A. brevispica* Harms, *A. schweinfurthii* Brenan & Exell, *A. pentagona* (Schumacher) Hook. f. and allies in Africa and *A. riparia* H. B. K. and *A.*

paniculata Willd. in tropical America and the West Indies.

Although subgenus *Acacia* is well represented in both Africa and America no species is common to Africa and America; *A. farnesiana* is not indigenous in Africa having been introduced and subsequently become naturalized in some areas. *A. sieberana* in Africa shows some relationship to the American *A. macrantha* Humb. & Bonpl. ex Willd., an observation noted by Bentham (1875).

A feature shared by some species of subgenus *Acacia* in central America and in Africa is the production of swollen stipular spines and a mutualistic association of these spines with several species of ants, but the degree of mutualism in each continent differs. Some of the neotropical acacias with swollen spines, commonly referred to as swollen thorn acacias or 'bull's-horn acacias', have spicate inflorescences and others capitate inflorescences and the species do not appear to constitute a close phyletic unit, yet they share many adaptive ecological and morphological traits and, according to Janzen (1974), provide outstanding examples of evolutionary convergence. Janzen (*l.c.*) observed that the species of obligate acacia-ants in the New World are not specific to a swollen-thorn *Acacia* species, but rather to its life form. As an example he cited *A. colinsii* Safford, which has at least eight species of obligate acacia-ants living in it over its range from Mexico to Columbia, all of which also live in other swollen-thorn acacias.

The acacias with swollen spines in central America do not appear to occur south of Venezuela or Columbia (Janzen, 1966). The mutualistic interaction between ants and acacias in central America has been detailed in a series of papers by Janzen (1966, 1967a, 1967b) and subsequently summarized (Janzen, 1969a). Janzen (1969a) noted that the central American acacias with swollen stipular spines differ from the other *Acacia* species in the area in having:

1. partially hollow spines which are occupied by ants.
2. modified leaflet tips called Beltian bodies which constitute the primary source of protein and oil for the ant colony.
3. greatly enlarged foliar nectaries which supply the sugar requirements for the ant colony.
4. all-year-round leaf production on most individuals which provides a relatively constant source of food for the ants.
5. an absence of chemical and structural traits that protect other acacias from most herbivores in the environment. The ants are functionally analogous to the chemicals released by some plants in their competitive interactions with other plants; like these chemicals the ants are 'produced' at a metabolic cost to the plant (Janzen 1969b). Janzen (1966) expressed the view that the swollen-thorn acacias of central America have lost, apparently through evolutionary change, their ability to withstand the phytophagous insect damage and competitive pressure of neighbouring plants without the protection of the obligate acacia-ants.

Janzen concluded that those *Acacia* species with ants do not normally duplicate their defence systems and thus do not make toxic compounds such as cyanogenic glycosides in quantity. One exception he noted was *A. chiapensis* Safford which possesses both types of defence systems. Janzen (1974) concluded that *A. chiapensis* is a marginal host for obligate acacia-ants and in many features of growth and

habit resembles non-ant acacias (Rehr *et al.*, 1973). However, Siegler *et al.* (1978) found specimens of *A. hindsii* Benth., a species inhabited by an obligate acacia-ant, in Oaxaca and Jalisco to be strongly cyanogenic which is another exception to Janzen's earlier observation.

The swollen-thorn acacias occur in the wettest areas of tropical central America. As the drier areas are approached the acacia cannot retain its leaves long enough to keep the ant colony alive and the unoccupied shoot does not survive to maturity because of insect damage. In cooler areas the growth of the acacia is slower and the ants are apparently insufficiently active in cool weather to deter the phytophagous insects and vertebrate browsers adapted to cool weather and thus the acacia receives more damage than it can tolerate and the ant colony starves to death owing to a lack of leaf products.

All of the central American swollen-thorn acacias have a sweet pulp around the seeds and the seeds are dispersed by birds. Janzen (1969a) noted that there appeared to be 'a selective pressure acting on all the swollen-thorn acacias that favours bird-dispersal of seeds'. The species of swollen-thorn acacia with the widest distributions are those whose seeds are most readily removed by birds while those with seeds that are less easily removed have more restricted distributions. The birds begin dispersal of seeds as soon as the pods are ripe which is important to plants that lose 60–100% of a particular seed crop through the predations of the larvae of Bruchidae. As the initial infestation usually destroys 40–80% of the seeds and all seeds remaining on a tree have usually been killed within two months of seed maturation, the rapid removal of the seeds by birds is possibly critical to the survival of the *Acacia* species.

Like the central American species, the African species with swollen stipular spines, commonly called 'ant-galls', do not consist of a group of closely related species. Most of the African 'ant-gall' acacias have white or pale yellowish white flowers in capitate heads but some have deep yellow flowers and two species have spicate inflorescences. The African *Acacia* species with swollen spines vary from those which are apparently partially ant-dependent to those which have no regular mutualistic association with ants.

Hocking (1970) investigated the East African swollen-thorn acacias and, although he worked on several different species, concentrated on *A. drepanolobium* Harms ex Sjöstedt which is probably the most ant-dependent African species. Hocking found that while *A. drepanolobium* can be grown to at least flowering stage in the absence of ants and probably the ants can be raised without the *Acacia*, in nature the association is essentially an obligate one as the ants and *A. drepanolobium* seldom persist independently. No more than 1% of the *A. drepanolobium* plants in the study area were found to be without ant associates. It follows that advantage must accrue to both parties so that these associations are also mutualistic as in the case of the New World *A. cornigera* L. (Janzen 1966, 1967b). However, although converging on the central American system, the association between *A. drepanolobium* and the ants has not reached the same degree of development as that in the neotropics.

Several species in the '*A. drepanolobium* complex' are associated with ants to a lesser extent. At the other extreme are a number of species with swollen spines, for example *A. luederitzii* Engl. var. *retinens*

(Sim) J. H. Ross & Brenan, which have no mutualistic association with ants, the ants and other insects merely taking advantage of the hollow spines as suitable domatia. The hollow spines in *A. luederitzii* var. *retinens* and in several other species are frequently unoccupied and often entire plants lack any enlarged spines.

The African acacias with swollen spines differ from the American swollen-thorn species in the following respects:

1. they lack Beltian bodies at the tips of the leaflets. Hocking (*l.c.*) suggested that the occurrence of Beltian bodies at the tips of the leaflets in the New World *Acacia* species may ensure a more uniform distribution of ants on the foliage and be an adaptation to an environment in which phytophagous insects are a relatively greater threat than browsing herbivores.
2. they lack all-year-round leaf production.
3. they are not confined to the wettest areas. On the contrary, in Africa they occupy areas which experience a pronounced dry season. Hocking (*l.c.*) suggested that the establishment of ants on the African acacias may improve their adaptation to a dry environment through the pruning out, by the ants, of the axillary buds of the swollen stipules.
4. the extra-floral nectaries do not appear to be developed to the same extent.
5. the seeds are not surrounded by sweet pulp.
6. the seeds are not distributed by birds. In Africa some of the large herbivorous mammals rapidly disperse the seed of certain *Acacia* species, for example *A. tortilis* (Forssk.) Hayne, away from the parent plant and in so doing play a similar rôle to that played by birds in central America.

It is not known whether or not the African species lack the chemical and structural traits that protect the American acacias from most herbivores in the environment and the matter needs investigation.

The genera of ants involved in the mutualistic association with species of *Acacia* in Africa and in America differs as one might expect. *Pseudomyrmex* is the important ant genus in America while *Crematogaster* is the most important genus in Africa. The development of swollen spines and the mutualistic association with ants in Africa and in America appears to have taken place independently in each continent and represent an example of convergent evolution.

RELATIONSHIP BETWEEN THE AFRICAN AND THE MADAGASCAN AND MASCARENE SPECIES

Madagascar was connected with Africa into the mid-Cretaceous when it was situated against Tanzania-Kenya about 15° N of its present position (Axelrod & Raven, 1978). Madagascar then formed part of the now largely submerged Mascarene Plateau which joined India in the east into the late Cretaceous. Precisely when Madagascar-India separated from Africa is still not certain but it could have occurred at any time between the mid- and late Cretaceous. India separated from the Madagascar-Mascarene subcontinent early in the Paleocene about 65 million years ago and moved north to meet the Asian land mass by the middle Eocene about 45 million years ago (Axelrod & Raven, 1978).

Both subgenera *Acacia* and *Aculeiferum* are present in Africa and in Madagascar but, in addition, subgenus *Heterophyllum* occurs in Madagascar and

the Mascarenes. Subgenus *Heterophyllum* is essentially Australian so the occurrence of *A. xiphiolada* Bak. in Madagascar and *A. heterophylla* (Lam.) Willd. in the Mascarenes is of considerable phytogeographic interest. As species with phyllodes do not occur on the mainland of any other continent it is probably reasonable to assume that any species of *Acacia* with phyllodes now occurring outside of Australia must either have come from the Australian region or have been derived from species which have (Pedley, 1975). Bell & Evans (1978) found that the seed of *A. heterophylla* and all of the Australian species analysed showed a single characteristic amino acid pattern which led them to suggest that Australia and the Mascarene Islands once formed part of the same land mass and that the seed chemistry of subgenus *Heterophyllum* is the seed chemistry that characterized the ancestral species of Gondwanaland. *A. heterophylla* is superficially very similar to *A. koa* A. Gray which is endemic in the Hawaiian Islands some 15 000 kilometres away but differs in characters of the corolla, pod, seed and seedlings (Vassal, 1969). Carlquist (1965) postulated that *A. koa* and *A. heterophylla* are probably descendants of seeds which floated from Australia into the Pacific and Indian Oceans respectively. While this may be true, both species are, however, tetraploid and probably not primitive.

Despite the close proximity of Madagascar to Africa, as far as is known only one indigenous species in subgenus *Aculeiferum*, namely *A. rosvumae* Oliv., is common to both Africa and Madagascar. In tropical east Africa *A. rosvumae* occurs on or near the coast and the appearance of the pods suggests that they are indehiscent and water-borne. If the pods are indeed dispersed by water this may possibly account for the occurrence of the species in Africa and in Madagascar and it seems reasonable to assume that migration of the species between the two areas took place in geologically recent time. There is a very doubtful and unlikely record of *A. pervillei* Benth., a Madagascan species, from Delagoa Bay, Mozambique, but the most likely explanation is that the label does not belong with the specimen (Ross, 1973). Bentham (1875) was of the opinion that *A. pervillei* was more closely allied to the South American *A. lacerans* Benth. than it is to any other Old World species. There is no recent taxonomic revision of the Madagascan species and several of the species are insufficiently known.

RELATIONSHIP BETWEEN THE AFRICAN AND INDIAN SPECIES

There are far fewer *Acacia* species in India than in Africa but both subgenera *Acacia* and *Aculeiferum* are present in Africa and in India and, moreover, two species in each subgenus are common to each land mass which provides clear evidence of a close relationship between the Indian and African acacias. Although migration between Africa and India is now extremely difficult or perhaps impossible because of the intervening arid areas, in former times the two areas were connected by a belt of tropical forest and savanna and direct migration was possible. The fact that a number of the acacias in India and in Africa, in areas that are now widely separated, cannot be distinguished at specific level suggests that their separation is geologically relatively recent and was attained when direct migration was possible between India and Africa and not when India 'rafted' north-

TABLE 4.—Species common to Africa and India and the infraspecific taxa recorded within each species

Africa	India
<i>A. horrida</i> (L.) Willd. subsp. <i>benadiensis</i> (Chiov.) Hillcoat & Brenan	<i>A. horrida</i> subsp. <i>horrida</i>
<i>A. nilotica</i> (L.) Willd. ex Del. subsp. <i>nilotica</i> subsp. <i>tomentosa</i> (Benth.) Brenan subsp. <i>adstringens</i> (Schumach. & Thonn.) Roberty subsp. <i>subalata</i> (Vatke) Brenan subsp. <i>kraussiana</i> (Benth.) Brenan subsp. <i>leiocarpa</i> Brenan	<i>A. nilotica</i> subsp. <i>indica</i> (Benth.) Brenan [subsp. <i>hemispherica</i> Ali & Faruqi and subsp. <i>cupressiformis</i> (J. L. Stewart) Ali & Faruqi occur in Pakistan]
<i>A. polyacantha</i> Willd. subsp. <i>campylacantha</i> (Hochst. ex A. Rich.) Brenan	<i>A. polyacantha</i> subsp. <i>polyacantha</i>
<i>A. senegal</i> (L.) Willd. var. <i>senegal</i> var. <i>kerensis</i> Schweinf. var. <i>leiorhachis</i> Brenan var. <i>rostrata</i> Brenan	<i>A. senegal</i> var. <i>senegal</i>

wards after breaking from Africa with Madagascar about 100 million years ago (Raven & Axelrod, 1974) or perhaps earlier (Schuster, 1976) otherwise one would have expected greater morphological diversification to have occurred. The morphological differences between the species common to Africa and India are mostly slight but the differences, taken together with the geographical discontinuity between the African and Indian populations, have been considered sufficiently significant to warrant the populations being regarded as subspecifically or varietally distinct (see Table 4).

In addition to these species which are common to both Africa and India, the Indian *A. pennata* (L.) Willd., one of the climbers with scattered recurved prickles in subgenus *Aculeiferum*, is extremely closely related to a number of African species such as *A. brevispica*, *A. schweinfurthii*, *A. pentagona* and allies. Once again, the degree of similarity between *A. pennata* and the African species suggests that their separation is geologically relatively recent. It is clear that there is a much closer affinity between the African and Indian species than there is between the African and South American species.

Although not present in India, *A. tortilis*, a member of subgenus *Acacia* which is widespread in Africa where it is represented by a number of subspecies, extends into Arabia as do several other African species. *A. gerrardii* Benth. is represented in the Negev Desert by subsp. *negevensis* Zohary, this subspecies being separated from all of the other variants in Africa by a wide geographical discontinuity.

The Indian species *A. ferruginea* (Roxb.) DC., a member of subgenus *Aculeiferum*, has some pollen characteristics which are specific to the Australian subgenus *Heterophyllum*, while at least twenty-six species in subgenus *Heterophyllum* have a porate type of pollen with simple apertures which is characteristic of subgenus *Aculeiferum* (Guinet & Vassal, 1978) illustrating the apparent close relationship between subgenera *Aculeiferum* and *Heterophyllum*.

RELATIONSHIP BETWEEN THE AFRICAN AND AUSTRALIAN SPECIES

The vast majority of the *Acacia* species (830 species fide Hopper & Maslin, 1978) occur in Australia

where considerable morphological diversity has occurred. *Acacia* is represented in Africa by subgenera *Acacia* and *Aculeiferum* and in Australia by subgenera *Acacia*, *Aculeiferum* and *Heterophyllum*. Most of the Australian species (over 800) belong to subgenus *Heterophyllum*, which is basically Australian (including Tasmania and New Guinea) although a few representatives also occur in Madagascar and the Mascarenes, the Pacific Islands and Hawaii. Although subgenera *Acacia* and *Aculeiferum* occur in Australia they are poorly represented on the continent, subgenus *Acacia* being represented by fewer than ten indigenous species mainly in the more northern parts of the continent (see Fig. 14) and subgenus *Aculeiferum* by the recently described endemic species (*A. albizioides* Pedley) which occurs in the vicinity of Coen in northern Queensland (see Fig. 15). The only species in subgenus *Acacia* common to Africa and Australia is *A. farnesiana* (apart from *A. nilotica*, *A. karroo* and *A. albida* Del. which are fairly recent introductions into Australia) but, as already indicated, *A. farnesiana* was almost certainly introduced into Africa. Bentham (1864) stated that *A. farnesiana* had every appearance of being indigenous in Australia but doubt has been expressed from time to time (Pedley, 1979) as to whether or not the species is in fact indigenous. *A. farnesiana* has an extensive distribution in Australia covering over 5 million square kilometres (N. Hall, pers. comm.) which greatly exceeds that of any other member of subgenus *Acacia* in Australia or the distribution of all of the other members of the subgenus collectively (see Fig. 16). If *A. farnesiana* is not indigenous in Australia then presumably it must have been introduced prior to European settlement as the species was encountered in the inland areas of Australia by early explorers.

The Australian members of subgenera *Acacia* and *Aculeiferum* are not particularly well known; some members of subgenus *Acacia* are not yet described although the subgenus is currently being revised. Except for the pantropical *A. farnesiana* which has a diploid chromosome number of 52 and the naturalized *A. nilotica* subsp. *indica* (Benth.) Brenan in which $2n=44, 52, 104$ (Vassal, 1974), there are no chromosome data available for other Australian

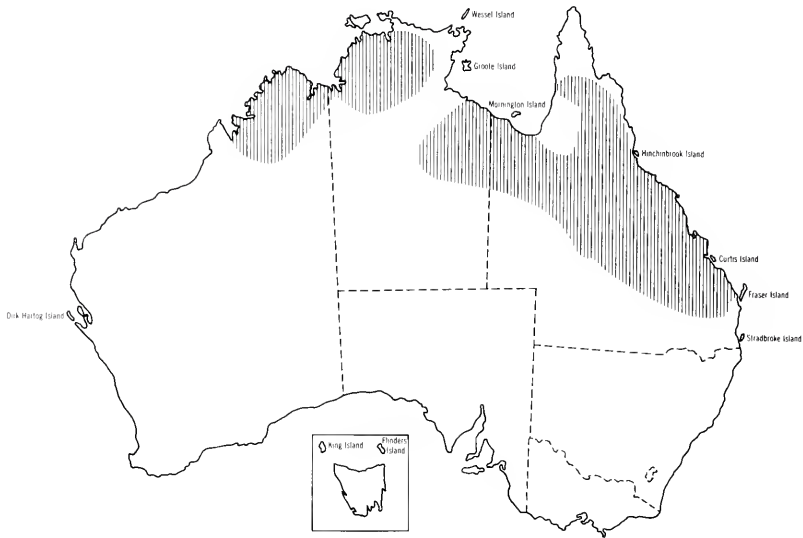


FIG. 14.—An indication of the general distribution of subgenus *Acacia* in Australia (excluding *A. farnesiana*).

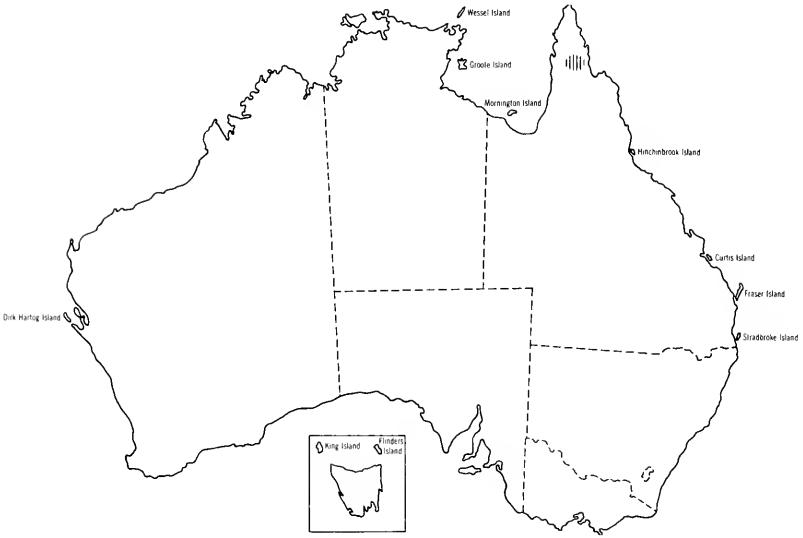


FIG. 15.—An indication of the distribution of subgenus *Aculeiferum* in Australia.

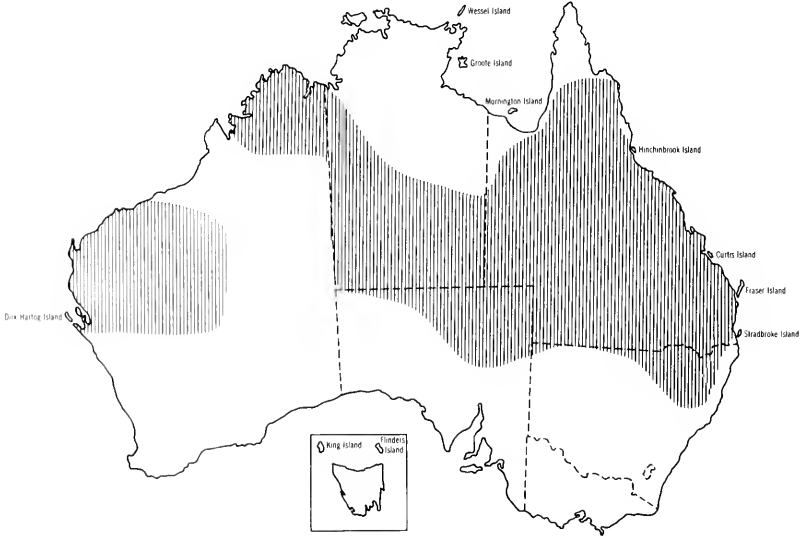


FIG. 16.—An indication of the general distribution of *Acacia farnesiana* in Australia.

members of subgenus *Acacia* and none for the solitary representative of subgenus *Aculeiferum*.

The contemporary Australian *Acacia* species appear to present a contradiction. On the one hand the majority of the Australian species (members of subgenus *Heterophyllum*) are unique and differ significantly from all of the other species in other regions (except for the few outliers discussed by Pedley, 1975) which suggests that they have evolved in isolation, while on the other hand this uniqueness is contradicted by the presence of a handful of species in subgenus *Acacia* and the solitary representative of subgenus *Aculeiferum* which share a number of the characters found in members of the respective subgenera elsewhere. This would seem to suggest that *Acacia* may have entered Australia on more than one occasion. For example, it would appear that the solitary member of subgenus *Aculeiferum* has entered Australia from New Guinea in geologically recent time, perhaps before the separation of Australia and New Guinea in the late Pleistocene. The other alternative is that the species is a relic. The important questions to which answers will have to be found are, firstly, when did *Acacia* first enter the Australian region and, secondly, from where.

There would appear to be two possibilities, namely, either the ancestors of *Acacia* must have been present in the Australian region at the time of the fragmentation of Gondwanaland although there is no evidence that the ancestors had differentiated at this stage or else the genus entered the region during the Tertiary. According to Raven & Axelrod (1974) geological evidence suggests the possibility of more or less direct migration between West Gondwanaland, combined Africa and South America, and East Gondwanaland, combined Australasia and Antarctica, up until the close of the early Cretaceous about 110 million years ago (± 10 million years). When the connection between Africa and Australasia was severed is not clear, but it is possible that Madagascar and India served as a subtropical route of migration, perhaps somewhat interrupted, to Australasia into the late Cretaceous. Once the migration of tropical alliances by this route was no longer possible, Australasia was connected with the rest of the world by a cool-temperate pathway to South America via Antarctica up until about 45 million years ago. However, the present mainly tropical and subtropical global distribution of *Acacia*, the absence of species from the southern portion of South America and the few species in the southern tip of South Africa and in Tasmania, suggests that *Acacia* did not enter Australia from the south via this cool-temperate route as some other genera such as *Nothofagus* appear to have done. In general, the ease of migration to Australasia is believed to have decreased during the late Cretaceous to Paleogene only to increase again in the Neogene as the Australian plate neared Asia. Nevertheless, according to Raven & Axelrod (*l.c.*), migration between Australasia and Africa via India and Madagascar was probably relatively direct, but with fairly long steps over water, after the start of the Tertiary 65 million years ago.

The first recorded appearance of *Acacia* pollen in the Australian fossil record is in mid-Miocene deposits (± 16 million years ago) in southern Victoria (Cookson, 1954). To explain the apparent absence of *Acacia* pollen from Paleogene beds Cookson concluded that either the genus *Acacia* was not represented in the *Nothofagus*-conifer forests which are known to have covered large areas of Australia during the early Tertiary period or else the

genus did not become an integral part of the Australian flora as a whole until after the Lower Miocene period (25 million years ago). Although the evidence was not conclusive, Cookson favoured the latter possibility.

If Cookson's view that *Acacia* did not occur in Australia prior to the Lower Miocene is correct, then either subgenus *Heterophyllum* developed in Australia after the Lower Miocene, probably from subgenus *Aculeiferum* and possibly from a species such as the Indian *A. ferruginea* or its ancestors, or else subgenus *Heterophyllum* entered Australia after the Lower Miocene after developing elsewhere in an area where it has since become extinct except for isolated species such as *A. confusa* Merr., *A. koa*, *A. heterophylla* and *A. xiphioclada*. The occurrence of the same seed amino acid pattern in *A. confusa*, which occurs in the Pacific Islands and Taiwan, as that found in the seeds of African and Asian species suggested to Evans *et al.* (1977) that this species originated in Asia rather than in Australia.

Another possibility, however, is that the genus may have been established in Australia prior to the Lower Miocene but confined to the northern part of the continent. The suggestion that *Acacia* first became established on the northern part of the Australian plate and later spread to other parts of the continent when suitable conditions prevailed for it to do so was advanced by Andrews (1914) and supported by Pedley (1975). Vassal (1972), on the other hand, considered that the primitive section of subgenus *Heterophyllum* probably occupied the whole of the Australian continent at the beginning of the Tertiary.

Although the centre of present-day development of species in a subgenus need not necessarily reflect the centre of past development, the great diversity exhibited by subgenus *Heterophyllum* in Australia and the lack of close relatives on other continents suggests that subgenus *Heterophyllum* developed in Australia from which source a few species such as *A. confusa*, *A. koa* and *A. heterophylla* were subsequently dispersed to other areas and that the subgenus did not enter Australia after developing elsewhere. It is tempting to speculate that subgenus *Acacia* entered northern Australia where it has since largely remained in the mid-Tertiary (or perhaps even later) when Australia came into contact with the south-east Asian plate but it is difficult to account for the poor representation of subgenus *Aculeiferum* in Australia.

As Australia was separated from Africa and India by a considerable marine gap and was distant from any other tropical land mass for millions of years until late in the Oligocene when contact was made with the south-east Asian plate, Melville (1975) concluded that 'the characteristic Australian flora — excluding the Indo-Malaysian element of relatively recent origin — must have evolved *in situ* from ancestors of Permian age'. Melville (*l.c.*) continued that 'Acceptance of this conclusion implies that evolutionary trends in many families such as *Proteaceae*, *Resionaceae*, *Leguminosae* and *Compositae*, must have been initiated already in the Permian for the observed parallel evolution to have taken place subsequently on separated Gondwanic fragments'.

Irrespective of when the genus first became established in Australia and from where it came its development and subsequent spread over the continent have been influenced by past geological and climatic changes. During the period from the Triassic, until

northward drift began in the Eocene, Australia was situated about 15° south of its present latitude (Jones, 1971).

The Australian Tertiary pollen record is largely that of rainforest which must have been widespread, though not necessarily continuous, over the southern part of the continent (Martin, 1978). The high content of gymnosperms in the Australian Paleocene assemblages is thought to indicate a cool temperate climate similar to present-day Tasmania (Martin, *l.c.*). The subsequent increase in Myrtaceae and other angiosperms is taken to indicate a relative increase in temperature to a warm temperate or subtropical climate. Temperatures reached the maximum for the Tertiary in the early Eocene and the dramatic increase in *Nothofagus* in the mid-Eocene marks the onset of a cooling trend although further fluctuations were experienced. The Oligocene to early Miocene was a period of an equable climate with very high rainfall and stable temperatures while the mid-late Miocene was a time of profound change when *Nothofagus* and many other taxa disappeared from the fossil record in south-eastern Australia (Martin, 1977). During the late Miocene and Pliocene a moderate rainfall and drier type of vegetation existed and it is thought that remnants of lower Tertiary flora existed in small refuge areas in the eastern highlands and migrated westwards when the climate became wetter for a relatively brief period in the late Pliocene (Martin, 1977). There is every indication that aridity increased subsequent to Pliocene time and the climate became more seasonal with a well-marked dry period and it is not until the Pleistocene that grasslands and/or savanna woodlands became prominent in south-eastern Australia. According to Gill (1975) it was only at this stage about two million years ago that the full opportunity for speciation in *Acacia* and *Eucalyptus* occurred. As aridity intensified closed forest would have been eliminated from all but locally favourable sites in north-eastern Australia.

In rainforest areas *Acacia* species are confined to marginal areas and clearings and it is only when the canopy is disturbed that the light requiring elements of the Australian flora become established (Burbidge, 1960). The retreat of closed forest with increasing aridity would have favoured the dispersal of *Acacia* species and the fossil finds discussed by Cookson (1954) possibly indicate an expansion in the distributional range of *Acacia* which coincided with the retreat of *Nothofagus*. Hopper & Maslin (1978) suggested that the recent speciation in *Acacia* in Western Australia has been promoted by recurrent migration, extinction and isolation of populations as a result of Pleistocene climatic fluctuations and their erosional consequences in climatically transitional areas. The possible dispersal of *Acacia* in Australia as a whole is dealt with by Pedley (1980).

Apart from the obvious differences such as the development of phyllodes in many members of subgenus *Heterophyllum* in Australia and the differences between the three subgenera in pollen, chromosomes, seeds, seedlings, inflorescences and pods alluded to by Guinet & Vassal (1978), there are other differential tendencies between subgenus *Heterophyllum* and the African representatives of subgenera *Acacia* and *Aculeiferum* which are briefly discussed here.

1. The African species (except *A. albida*) are invariably deciduous during the dry season, either regularly

or irregularly so, while the Australian members of subgenus *Heterophyllum* are invariably evergreen. The only Australian species thought to be deciduous is *A. ditricha* Pedley, a member of subgenus *Acacia*, but it is possible that some other members of this subgenus are also deciduous.

2. The flattened spreading crowns which are so characteristic of some of the African species such as *A. tortilis* subsp. *heteracantha* (Burch.) Brenan and subsp. *spirocarpa* (Hochst. ex A. Rich.) Brenan, *A. sieberana* var. *woodii* (Burt Davy) Keay & Brenan, *A. lahai* Steud. & Hochst. ex Benth. and *A. abyssinica* Hochst. ex Benth. subsp. *calophylla* Brenan are absent amongst the Australian species. One explanation advanced for the flattened crowns in Africa is that it is an adaptive response to browsing (Brown, 1960). Another suggestion that has been offered is that it is the result of insolation damaging the apical growing buds, but if this was the case it is strange that none of the Australian species has developed the same adaptive response where the effects of insolation are as great as they are in Africa. The African species in general 'look' different to most of the Australian members of subgenus *Heterophyllum*.

3. The stipules in all African members of subgenus *Acacia* are spinescent and invariably very prominent and in the Australian members of the subgenus the stipules are typically spinescent at least when young although they are usually small or occasionally absent. The stipules in subgenus *Heterophyllum* are, with few exceptions, small, inconspicuous and often deciduous. Many of the species are entirely unarmed but in others spinescence has arisen in various ways through the modification of phyllodes, branchlets and peduncles. *A. paradoxa* DC. and *A. victoriae* Benth. are exceptional in having stipular spines although those of the latter are sometimes reduced to blunt outgrowths, and stipular spines also occur in some of the Western Australian species (Pedley, 1978). Stipular spines are far better developed in the African species of subgenus *Acacia* than they are in the Australian members of subgenus *Acacia* or in subgenus *Heterophyllum*. Brown (1960) suggested that '*Acacia* in Australia passed through an earlier period in which spininess had little adaptive value, followed by a time in which selective pressures again arose favouring the development of spines *de novo* in shrubs of the forested country and in the lower shrubs of the open country'.

Brown (*l.c.*) attributed the lack of spinescence in many of the Australian *Acacia* species and in other dominant genera like *Eucalyptus* to the 'long-continued absence or scarcity of effective large browsers' until the recent introduction of domesticated animals. Large browsing herbivores are now or have recently been abundant in Africa and in tropical America in areas where spinescent acacias occur and certainly in Africa the acacias constitute an important source of food for many browsing mammals. However, the argument loses some validity as many species in other genera have survived browsing pressure without the aid of spines although admittedly they may have developed other deterrents such as offensive chemical attributes to discourage large browsers. No similar radiation of large browsers appears to have occurred in Australia, the endemic Australian mammal fauna consisting of marsupials, monotremes, rodents and bats. Of these, the kangaroo is the largest survivor but kangaroos are chiefly

grazers and it seems reasonable to assume that the extinct giant kangaroos were also grazers. Brown (*l.c.*) considered the development of spininess in many of the smaller shrubby acacias, grasses and other shrubs of the closed forest understandable seeing that kangaroos, smaller marsupials and rodents feed on them.

None of the Australian members of subgenus *Acacia* has swollen stipular spines which are so characteristic of some of the African and American species and none of the Australian species has formed any mutualistic association with ants although the seeds of many Australian plants, including some *Acacia* species, are dispersed short distances by ants (Berg, 1975). The Australian continent is richly endowed with ants so the lack of a mutualistic association between acacias and ants cannot be due to a scarcity of ants. Hocking (1970) suggested that if the Australian members of subgenus *Acacia* ever had the tendency to produce swollen spines then presumably the expression of the character has been lost under reduced selection pressure from herbivorous animals. The extra-floral nectaries in the Australian members of subgenus *Acacia* are small.

4. A number of the Australian members of subgenus *Heterophyllum* flourish in a cold and wet environment in southern Victoria and Tasmania far further south than on any other continent and have occupied a habitat that is generally avoided by the indigenous African species. The African species tolerate hot and dry, hot and wet, and cold and dry habitats but where cold and wet conditions persist for any great period of the year acacias are usually infrequent in their occurrence or absent.

5. The African species invariably flower in spring or early summer and the inflorescences are usually produced with or before the young leaves. In contrast, the Australian members of subgenus *Heterophyllum* are evergreen and a number of species flower in winter.

6. The anthers of nearly all of the African species (except *A. albida* and *A. redacta*, neither of which it has been suggested is referable to *Acacia*, Robbertse & Von Teichman, 1979) are adorned with a small apical deciduous gland but none of the Australian members of subgenus *Heterophyllum* appear to have glands on the anthers. The function of the glands in the African species is not clear but Hocking (1970) suggested that the tissue filling the glands may contain useful amounts of nitrogenous material which may be utilised by phytophagous insects. *A. bidwillii* Benth. and *A. sutherlandii* (F. Muell.) F. Muell., both Australian members of subgenus *Acacia*, have anthers with small deciduous apical glands but I have not seen suitable material of other Australian members of the subgenus, except of *A. farnesiana* which lacks the glands, to establish whether they also have the deciduous glands. This needs further investigation.

7. Some of the Australian members of subgenus *Heterophyllum* have seed with conspicuous brightly coloured arils, whereas none of the African species does.

8. Bruchids are responsible for the destruction of vast quantities of seeds of some American and African species in subgenera *Acacia* and *Aculeiferum* whereas seeds of the Australian species are relatively unaffected by bruchids, probably because few indigenous species of bruchid occur in Australasia and the Pacific Islands (Southgate, 1978). A survey of the

free non-protein amino acids in the seeds of 106 *Acacia* species by Evans *et al.* (1977) revealed that the genus can be divided into four biochemically different groups on the basis of their seed chemistry and Southgate (*l.c.*) suggested that one of the factors influencing the ability of bruchid larvae to survive within a seed may be the level of certain amino acids, notably pipercolic acid and some heteropolysaccharides. The amino acid composition of the seed of the Australian members of subgenus *Heterophyllum* differs from that of the seed of members of other subgenera, and a possible explanation for this may be that members of subgenus *Heterophyllum* have apparently evolved without the selection pressure of bruchid predation.

DISCUSSION

As a result of the multidisciplinary approach to *Acacia* in recent years much evidence has accumulated which indicates that fundamental differences exist between subgenera *Acacia* and *Aculeiferum*, and that subgenus *Aculeiferum* is more closely related to subgenus *Heterophyllum* despite the fact that they occupy basically different geographical areas which show relatively little overlap, than are subgenera *Acacia* and *Aculeiferum* which share a common geographical area. The differences between subgenera *Acacia* and *Aculeiferum* are such that it is considered unlikely that the one gave rise to the other directly but rather that they arose from a common or similar prototype. Many questions concerning the origin, evolution and dispersal of the genus and of the relationships within it remain to be answered to enable a better understanding to emerge.

Although the African *Acacia* species have received a considerable amount of attention during the last few decades they remain inadequately known and numerous taxonomic problems await elucidation. Despite the incompleteness of the information on the distribution of the African species the overall patterns that emerge are probably sufficiently accurate to be of value. Further collecting, especially in tropical north-east Africa and in west tropical Africa, will resolve some of the taxonomic problems and provide more accurate information on the distributions of many species.

Some species in subgenus *Aculeiferum* are almost as widespread in Africa as the most widespread members of subgenus *Acacia*, but the distribution of subgenus *Acacia* as a whole in Africa exceeds that of subgenus *Aculeiferum*. That subgenus *Acacia* enjoys a wider range of distribution than subgenus *Aculeiferum* suggests that the former has been able to occupy habitats from which the latter has been excluded and the possibility exists that it has been assisted in this by the greater genetic plasticity conferred on it as a consequence of its members being polyploid. On the other hand, climbing members of subgenus *Aculeiferum* have been successful in forested areas of the continent in which subgenus *Acacia* is not represented, the climbing habit, which is not known in subgenus *Acacia* in Africa, enabling species to take advantage of suitable sites in forested areas. The highest concentration of species in each subgenus occurs in tropical north-east, east and south-east Africa but different parts of the continent have been important areas of local speciation for each subgenus, the highest concentration of endemic species in subgenus *Acacia* occurring in Tanzania and the highest concentration of endemics in subgenus *Aculeiferum* in Somalia.

Despite the advances in our knowledge of the African species in recent decades, detailed population studies are required and information is needed on their biology and autecology. Only when such a reservoir of information is available will a better understanding of the African species emerge. And, what is true for the African species applies equally to those in other continents. It would be highly beneficial as a first step to have a conspectus of the *Acacia* species occurring on each continent reflecting the current state of taxonomic knowledge along the lines of that produced for the African species (Ross, 1979) or the more detailed revision of Queensland species (Pedley, 1978, 1979), and ultimately a conspectus of the genus as a whole. This is, of course, a fairly formidable task especially when one considers the Australian species but much valuable work has already been done on the Australian species. Hopefully, a conspectus of the Australian species will be prepared before too long. *Acacia* is a fascinating genus, which commends itself to further study.

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UITTREKSEL

Die drie subgenera wat in die genus *Acacia* erken word, word in hooftrekke beskrywe en die globale verspreiding van elk word aangedui. Die verskille tussen die subgenera en die graad en verwantskap en vlakke van spesialisasie word kortliks bespreek. Die voorstel word gemaak dat die voorouers van die genus klim- of slingerplante was. Geologiese gebeure in die verlede wat 'n moontlik invloed op die verspreiding van *Acacia*-spesies in Afrika kon gehad het, word geskets. Die aantal spesies wat vir elke land in Afrika aangeteken is word getabuleer en die verspreiding en konsentrasie van spesies binne die genus *Acacia* as geheel en binne elke subgenus in Afrika word geïllustreer. Die hoogste konsentrasie van spesies binne elke subgenus kom in oos en suid-oos tropiese Afrika voor. Die verspreiding van spesies in sommige van die afsonderlike Afrika-lande en moontlike verwantskappe word bespreek en die aandag word op die hoofsentra van endemisme gevestig. Die verspreiding van die spesies van Afrika word met die hoof fito-geografiese streke wat op die vasteland erken word, in verband gebring. Die verwantskappe tussen die *Acacia* spesies van Afrika, Amerika, Malgassie, Indië en Australië word kortliks bespreek.

REFERENCES

- ANDREWS, E. C., 1914. Development and distribution of the natural order Leguminosae. *J. Proc. R. Soc. New South Wales* 48: 333-407.
- ATCHISON, E., 1948. Studies in the Leguminosae. 11. Cytogeography of *Acacia* (Tourn.) L. *Am. J. Bot.* 35: 651-655.
- AXELROD, D. I., 1972a. Ocean-floor spreading in relation to ecosystemic problems. *Univ. Arkansas Mus. Occas. Paper* 4: 15-76.
- AXELROD, D. I., 1972b. Edaphic aridity as a factor in angiosperm evolution. *Am. Nat.* 106: 311-320.
- AXELROD, D. I. & RAVEN, P. H., 1978. Late Cretaceous and Tertiary vegetation history of Africa. In M. J. A. Werger (ed.), *Biogeography and ecology of southern Africa* 1: 77-130. The Hague: W. Junk.
- BELL, E. A., 1971. Comparative biochemistry of non-protein amino-acids. In J. B. Harborne, D. Boulter & B. L. Turner (eds), *Chemotaxonomy of the Leguminosae* 179-206. New York: Academic Press.
- BELL, E. A. & EVANS, C. S., 1978. Biochemical evidence of a former link between Australia and the Mascarene Islands. *Nature* 273: 295-296.
- BENTHAM, G., 1864. *Flora Australiensis* Vol. 2. London: Lovell Reeve & Co.
- BENTHAM, G., 1875. Revision of the suborder Mimoseae. *Trans. Linn. Soc. Lond.* 30: 335-664.
- BERG, R. Y., 1975. Myrmecochorous plants in Australia and their dispersal by ants. *Aust. J. Bot.* 23: 475-508.
- BRENNAN, J. P. M., 1979. Some aspects of the phytogeography of tropical Africa. *Ann. Mo. bot. Gdn* 65: 437-478.
- BROWN, W. L., 1960. Ants, Acacias and browsing mammals. *Ecology* 41: 587-592.
- BURBRIDGE, N. T., 1960. The phytogeography of the Australian region. *Aust. J. Bot.* 8: 75-211.
- BURTT, B. L., 1971. From the South: an African view of the floras of western Asia. In P. H. Davis, P. C. Harper & I. C. Hedge (eds), *Plant life of South-West Asia* 134-149. Edinburgh: Edinburgh Botanical Society.
- CARLQUIST, S., 1965. *Island life*. New York: Nat. Hist. Press.
- CHAPMAN, J. D. & WHITE, F., 1970. *The evergreen forests of Malawi*. Oxford: Commonwealth Forestry Institute, University of Oxford.
- COOKSON, I. C., 1954. The Cainozoic occurrence of *Acacia* in Australia. *Aust. J. Bot.* 2: 52-59.
- CROCKER, R. L., 1959. Past climatic fluctuations and their influence upon Australian vegetation. In A. Keast, R. L. Crocker & C. S. Christian (eds), *Biogeography and ecology in Australia* 283-290. The Hague: W. Junk.
- DE WINTER, B., 1971. Floristic relationships between the northern and southern arid areas of Africa. *Mitt. bot. Stsamm., Münch.* 10: 424-437.
- EVANS, C. S., QURESHI, M. Y. & BELL, E. A., 1977. Free amino acids in the seeds of *Acacia* species. *Phytochemistry* 16: 565-570.
- FRANKS, L. A. & KEMP, E. M., 1972. The influence of continental positions on early Tertiary climates. *Nature* 240: 97-100.
- GILL, E. D., 1975. Evolution of Australia's unique flora and fauna in relation to the plate tectonics theory. *Proc. R. Soc. Vict.* 87: 215-234.
- GMEIN, R., 1959. Die freien aminosäuren der samen von *Acacia willardiana* (Mimosaceae). *Hoppe-Seyl. Z.* 316: 164-169.
- GOLDBLATT, P., 1979. An analysis of the Flora of Southern Africa: its characteristics, relationships, and origins. *Ann. Mo. bot. Gdn* 65: 369-436.
- GUINET, Ph., 1967. Parallélisme entre les caractères du pollen dans les groupes Piptadeniées et Acaciées des Mimosacées. *Rev. Paléobot. Palynol.* 3: 151-153.
- GUINET, Ph., 1969. Les Mimosacées. Etude de palynologie fondamentale, corrélations, évolution, *Trav. Sect. Sci. Tech. Inst. Fr. Pondichery* 9: 1-203.
- GUINET, Ph. & VASSAL, J., 1978. Hypotheses on the differentiation of the major groups in the genus *Acacia* (Leguminosae). *Kew Bull.* 32: 509-527.
- HEPPER, F. N., 1965. Preliminary account of the phytogeographical affinities of the Flora of West Tropical Africa. *Webbia* 19: 593-617.
- HICKEY, L. J. & DOYLE, J. A., 1977. Early Cretaceous fossil evidence for angiosperm evolution. *Bot. Rev.* 43: 3-104.
- HOCKING, B., 1970. Insect associations with the swollen thorn acacias. *Trans. R. ent. Soc. Lond.* 122: 211-255.
- HOPPER, S. D. & MASLIN, B. R., 1978. Phytogeography of *Acacia* in Western Australia. *Aust. J. Bot.* 26: 63-78.
- HUNDE, A., 1979. *Acacia amyethophylla*, the correct name of a widespread African tree. *Bot. Notiser* 132: 393-395.
- JANZEN, D. H., 1966. Coevolution of mutualism between ants and Acacias in Central America. *Evolution* 20: 249-275.
- JANZEN, D. H., 1967a. Fire, vegetation structure, and the ant x acacia interaction in Central America. *Ecology* 48: 26-35.

- JANZEN, D. H., 1967b. Interaction of the bull's-horn acacia (*Acacia cornigera* L.) and an ant inhabitant (*Pseudomyrmex ferruginea* F. Smith) in eastern Mexico. *Univ. Kans. Sci. Bull.* 47: 315–558.
- JANZEN, D. H., 1969a. Birds and the ant \times acacia interaction in Central America, with notes on birds and other myrmecophytes. *Condor* 71: 240–256.
- JANZEN, D. H., 1969b. Allelopathy by myrmecophytes: the ant *Azteca* as an allelopathic agent of *Cecropia*. *Ecology* 50: 147–153.
- JANZEN, D. H., 1974. Swollen-Thorn Acacias of Central America. *Smithson. Contr. Bot.* 13: 1–131.
- JOHNSON, L. A. S. & BRIGGS, B. G., 1975. On the Proteaceae — the evolution and classification of a southern family. *Bot. J. Linn. Soc.* 70: 83–182.
- JONES, J. G., 1971. Australia's Caenozoic drift. *Nature* 230: 237–239.
- KEMP, E. M., 1978. Tertiary climatic evolution and vegetation history in the southeast Indian Ocean region. *Palaeogeog. Palaeoclim. Palaeoecol.* 24: 169–208.
- KING, L. C., 1967. *The morphology of the Earth*. Edn 2. New York: Hafner.
- LEROY, J. F., 1979. Composition, origin, and affinities of the Madagascan vascular flora. *Ann. Mo. bot. Gdn* 65: 535–589.
- MARTIN, H. A., 1977. The history of *Ilex* (Aquifoliaceae) with special reference to Australia: evidence from pollen. *Aust. J. Bot.* 25: 655–673.
- MARTIN, H. A., 1978. Evolution of the Australian flora and vegetation through the Tertiary: evidence from pollen. *Alcheringa* 2: 181–202.
- MELVILLE, R., 1975. The distribution of Australian relict plants and its bearing on angiosperm evolution. *Bot. J. Linn. Soc.* 71: 67–88.
- MILDENHALL, D. C., 1972. Fossil pollen of *Acacia*-type from New Zealand. *N. Z. J. Bot.* 10: 485–494.
- MILDENHALL, D. C., 1975. Palynology of the *Acacia*-bearing beds in the Komako district, Pohangina Valley, North Island, New Zealand. *N. Z. J. Geol. Geophys.* 18: 209–228.
- MOLL, E. J. & WHITE, F., 1978. The Indian Ocean coastal belt. In M. J. A. Werger (ed.), *Biogeography and ecology of southern Africa* 1: 561–598. The Hague: W. Junk.
- MOREAU, R. E., 1952. Africa since the Mesozoic: with particular reference to certain biological problems. *Proc. zool. Soc. Lond.* 121: 869–913.
- MULLER, J., 1970. Palynological evidence on early differentiation of angiosperms. *Biol. Rev.* 45: 417–450.
- PEDLEY, L., 1975. Revision of the extra-Australian species of *Acacia* subgenus *Heterophyllum*. *Contr. Queensland Herb.* 18: 1–24.
- PEDLEY, L., 1978. A revision of *Acacia* Mill. in Queensland. Part 1. *Austrobaileya* 1, 2: 75–234.
- PEDLEY, L., 1979. A revision of *Acacia* Mill. in Queensland. Part 2. *Austrobaileya* 1, 3: 235–337.
- PEDLEY, L., 1980. Derivation and dispersal of *Acacia* (Leguminosae) with particular reference to Australia (in press).
- PLUMSTEAD, E., 1969. Three thousand million years of plant life in Africa. *Geol. Soc. S. Afr.*, Annexure to Vol. 72: 1–72.
- QUEZEL, P., 1979. Analysis of the Flora of Mediterranean and Saharan Africa. *Ann. Mo. bot. Gdn* 65: 479–534.
- RAVEN, P. H. & AXELROD, D. I., 1972. Plate tectonics and Australasian paleobiogeography. *Science* 176: 1379–1386.
- RAVEN, P. H. & AXELROD, D. I., 1974. Angiosperm biogeography and past continental movements. *Ann. Mo. bot. Gdn* 61: 539–673.
- REHR, S. S., FEENEY, P. & JANZEN, D. H., 1973. Chemical defenses in Central American non-ant-Acacias. *J. Anim. Ecol.* 42: 405–416.
- RICHARDS, P. W., 1973. Africa, the 'Odd Man Out'. In B. J. Meggers, E. S. Ayensu and W. D. Duckworth (eds), *Tropical forest ecosystems in Africa and South America: A comparative review* 21–26. Washington, D.C.: Smithsonian Inst. Press.
- ROBERTSE, P. J., 1974. The genus *Acacia* in South Africa, II, with special reference to the morphology of the flower and inflorescence. *Phytomorphology* 24: 1–15.
- ROBERTSE, P. J. & VON TEICHMAN, I., 1979. The morphology of *Acacia redacta* J. H. Ross. *Jl S. Afr. Bot.* 45: 11–23.
- ROSS, J. H., 1973. Notes on *Acacia* species in Southern Africa: III. *Bothalia* 11: 127–131.
- ROSS, J. H., 1974. Notes on *Acacia* species in Southern Africa: IV. *Bothalia* 11: 231–234.
- ROSS, J. H., 1979. A conspectus of the African *Acacia* species. *Mem. bot. Surv. S. Afr.* 44: 1–155.
- SCHUSTER, R. M., 1972. Continental movements, 'Wallace's line' and Indomalayan-Australasian dispersal of land plants: some eclectic concepts. *Bot. Rev.* 38: 3–86.
- SCHUSTER, R. M., 1976. Plate tectonics and its bearing on the geological origin and dispersal of angiosperms. In C. B. Beck (ed.), *Origin and early evolution of Angiosperms*. New York and London: Columbia Univ. Press.
- SEIGLER, D. S., DUNN, J. E., CONN, E. E. & HOLSTEIN, G. L., 1978. Acacetin from six species of *Acacia* of Mexico and Texas. *Phytochemistry* 17: 445–446.
- SHCHEKINA, N. A., 1965. On a find of polyads of the genus *Acacia* L. in the Neogene deposits of the Ukraine. *Ukr. Bot. Zhurn.* 22: 83–89.
- SOUTHGATE, B. J., 1978. Variation in the susceptibility of African *Acacia* (Leguminosae) to seed beetle attack. *Kew Bull.* 32: 541–544.
- STEBBINS, G. L. Jr., 1952. Aridity as a stimulus to plant evolution. *Am. Nat.* 86: 35–44.
- THORNE, R. F., 1972. Major disjunctions in the geographic ranges of seed plants. *Quart. Rev. Biol.* 47: 365–411.
- THORNE, R. F., 1973. Floristic relationships between tropical Africa and tropical America. In B. J. Meggers, E. S. Ayensu & W. D. Duckworth (eds), *Tropical forest ecosystems in Africa and South America: A comparative review* 27–47. Washington, D.C.: Smithsonian Inst. Press.
- THORNE, R. F., 1977. Where and when might the tropical angiospermous flora have originated? *Gdens' Bull.*, Singapore 29: 183–189.
- THORNE, R. F., 1978. Plate tectonics and angiosperm distribution. *Notes R. bot. Gdn Edinb.* 36: 297–315.
- TINDALE, M. D. & ROUX, D. G., 1974. An extended phytochemical survey of Australian species of *Acacia*: chemotaxonomic and phylogenetic aspects. *Phytochemistry* 13: 829–839.
- TINDALE, M. D. & ROUX, D. G., 1975. Phytochemical studies on the heartwoods and barks of African and Australian species of *Acacia*. *Boissiera* 24a: 299–305.
- VAN STEENIS, C. G. G. J., 1962. The land-bridge theory in botany. *Blumea* 11: 235–372.
- VAN ZINDEREN BAKKER, E. M., 1974. The evolution of late-quaternary palaeoclimates of southern Africa. *Palaeoecology of Africa* 9: 160–202.
- VAN ZINDEREN BAKKER, E. M., 1978. Quaternary vegetation changes in southern Africa. In M. J. A. Werger (ed.), *Biogeography and ecology in southern Africa* 1: 131–143. The Hague: W. Junk.
- VASSAL, J., 1969. A propos des *Acacias heterophylla* et *koa*. *Bull. Soc. Hist. nat. Toulouse* 105: 443–447.
- VASSAL, J., 1972. Apport des recherches ontogéniques et séminologiques à l'étude morphologique, taxonomique et phylogénique du genre *Acacia*. *Trav. Lab. Forest. Toulouse*, Tome 1, Vol. 8, Art. 17: 1–128. Reprinted from *Bull. Soc. Hist. nat. Toulouse* 108: 125–247.
- VASSAL, J., 1974. Reports on chromosome numbers in the genus *Acacia*. *Bull. International Group for Study of Mimosoideae* 2: 21–29.
- VERDCOURT, B., 1969. The arid corridor between the northeast and southwest areas of Africa. *Palaeoecology of Africa* 4: 140–144.
- WHITE, F., 1965. The savanna woodlands of the Zambezi and Sudanian Domains. *Webbia* 19: 651–681.
- WHITE, F., 1979. The Guineo-Congolian Region and its relationships on other phytochoria. *Bull. Jard. bot. nat. Belg.* 49: 11–55.
- WICKENS, G. E., 1976. The flora of Jebel Marra (Sudan Republic) and its geographical affinities. *Kew Bull. Add. Ser.* 5: 1–368.
- WILD, H., 1968. Phytogeography in South Central Africa. *Kirkia* 6: 197–222.
- WILD, H., 1974. Variations in the serpentine floras of Rhodesia. *Kirkia* 9: 209–232.
- WOOD, J. G., 1959. The phytogeography of Australia (in relation to radiation of *Eucalyptus*, *Acacia*, etc.). In A. Keast, R. L. Crocker & C. S. Christian (eds), *Biogeography and ecology in Australia* 291–302. The Hague: W. Junk.

Sexual nuclear division in *Neocosmospora**

K. T. VAN WARMELO**

ABSTRACT

The process of sexual nuclear division in authentic isolates of *Neocosmospora vasinfecta* E. F. Smith, *N. africana* Von Arx and a related species isolated from soybean was studied. No significant differences were found. Six chromosomes were counted in each isolate. There was no evidence of aneuploidy or irregular reconstitution of daughter nuclei. The divisions leading to the formation of binucleate, homokaryotic ascospores were typically meiotic.

RÉSUMÉ

DIVISION NUCLÉAIRE SEXUELLE CHEZ LE NEOCOSMOSPORA

Le processus de division nucléaire sexuelle dans des isolats authentiques de *Neocosmospora vasinfecta* E. F. Smith, *N. africana* Von Arx et une espèce apparentée isolée du soja a été étudié. Aucune différence significative n'a été trouvée. Six chromosomes ont été comptés dans chaque isolat. Il n'y eut aucune évidence d'aneuploidie ou de reconstitution irrégulière des noyaux filles. Les divisions conduisant à la formation du binucleate, d'ascospores homokaryotiques furent typiquement méiotiques.

INTRODUCTION

A fungus isolated from soybean stem material showed great similarity in morphology and dimensions to two existing species of *Neocosmospora*, i.e. *N. vasinfecta* and *N. africana*. In fact, the local culture could be placed almost equally well in either species. It was further noticed that there were very few morphological differences between the two existing species. A study was, therefore, undertaken to examine the differences and similarities in the various processes and structures of the local isolate and authentic cultures of the two similar species. This paper reports on the nuclear divisions leading to ascosporeogenesis.

REVIEW

The genus *Neocosmospora* was described in 1899 (Ferry, 1900). The type, and only species at that time, was *N. vasinfecta* (Atk.) Smith, derived from *Fusarium vasinfecta* Atk. (Seaver, 1909), which had been isolated from soil and had caused damping off of several types of cultivated plants.

Neocosmospora remained monotypic until Von Arx (1955) described a new species, *N. africana* Von Arx, which had been isolated from soil under grass-land plots near Johannesburg. *N. africana* has not yet been implicated as a plant pathogen (Udagawa, 1963).

According to Von Arx (1955) *N. africana* differed from *N. vasinfecta* only in possessing a smooth epispore which was fairly regular in thickness. Von Arx proposed that, despite the differences in external spore texture, his new species should be included in the genus *Neocosmospora*. The surface texture of ascospores from authentic culture of both species of *Neocosmospora* have been reported to show very little differences under scanning microscopic examination (Van Warmelo, 1976).

Doguet (1956) made a detailed examination of the development of the perithecia of both *N. vasinfecta*

and *N. africana* and found that it followed the same sequence in both species. This supported the statement by Von Arx (1955) that *N. africana* was similar to *N. vasinfecta* except for spore surface.

The process of meiosis in the fungi has received much attention and the mechanisms of division have been well described in a large variety of fungi (Olive, 1953 & 1965). Further significant contributions were made by Rogers (1964, 1965, 1967, 1968a, 1968b, 1968c & 1971), Lu (1966, 1967a & 1967b), Aldrich (1967), Barry (1967), Furtado (1970), Huguenin & Boccas (1970) and Wells (1970).

Division of the diploid nucleus follows a pattern basically similar to that established for the higher plants (Lu, 1966; Swanson, 1968; Woo & Partridge, 1969; Wells, 1970). There are, therefore, the same stages and processes during prophase I which lead to a recombination and segregation of chromatin after completion of the meiotic division. There are, however, some differences between the meiotic divisions in fungi and higher plants.

The nuclear membrane remains intact throughout the division (Huffman, 1968) or becomes discontinuous at the poles only (Aldrich, 1967). In these cases the spindles are fully intranuclear. Degeneration of the membrane also occurs, however, during the division, for example during anaphase (Wells, 1970), during metaphase (Olive, 1965; Lu, 1967b) and even as early as pachytene (Uecker, 1967).

The formation of a metaphase plate, which is infrequent in the fungi (Olive, 1965; Wells, 1970), was reported by Furtado (1970) and Rao & Mukerji (1970).

Centriolar plaques (also described as centrioles and centrosomes) occur in some organisms (Knox-Davies & Dickson, 1960; Lu, 1967a & 1967b; Uecker, 1967; Wells, 1970), but are absent in others (Aldrich, 1967).

Two types of fibres are found in the spindle, viz. chromosomal fibres which are attached to the chromosomes, and spindle fibres which are continuous between the centriolar plaques (Aldrich, 1967; Lu, 1967b; Wells, 1970). It is important to note

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that the spindle fibres may form in the absence of the centriolar plaques (Aldrich, 1967), in which case the fibres converge at the discontinuity of the nuclear membrane.

Asynchronous disjunction of chromosomes was frequently reported (Rogers, 1964, 1965, 1967; Olive, 1965; Uecker, 1967; Huffman, 1968; Furtado, 1969; Wells, 1970) and seems to be general in the fungi.

In the Pyrenomycetes the second meiotic division is commonly followed by a third division to give rise to eight haploid nuclei around which the ascospores then form (Singleton, 1953; Olive, 1965). Further division may take place within the delimited ascospores to give rise to multinucleate ascospores (Van Warmelo, 1966). Ascospores may, however, be delimited at the 16-nucleate stage (Furtado, 1970; Rao & Mukerji, 1970), or delimitation may occasionally be highly irregular (Rogers, 1967).

As a result of the frequency with which the regular processes of ascosporeogenesis have been found in the Pyrenomycetes, this pattern of development is generally applied to all Ascomycetes, even to species in which few details are available. However, extrapolated data can be misleading, as was shown by Rajendren (1967), who found that in *Hemileia vastatrix* the nuclear cycle did not agree entirely with that expected from earlier work on the Uredinales.

According to Doguet (1956) the ascogonium of *Neocosmospora vasinfecta* arises by somatogamy and gives rise to numerous ascogenous hyphae. Moreau & Moreau (1950), however, stated that dikaryotization occurs by means of a 'short antheridial filament', which associates closely with the coiled ascogonium. Doguet (1956) did not observe karyogamy in the penultimate cell of the crozier. The presence of nuclei with what appeared to be two nucleoli was, however, taken as an indication that karyogamy had occurred.

According to Doguet (1956) nuclear divisions in the ascus follow the normal pattern leading to the formation of eight binucleate ascospores. Unfortunately only very few drawings of the various divisions were published. Doguet also stated that the mechanism of ascosporeogenesis in *N. africana* is identical to that found in *N. vasinfecta*, implying that an ascogonium is formed by somatogamy and that the ascospores are binucleate. None of these stages was, however, illustrated.

MATERIALS AND METHODS

Three cultures were examined in this investigation:

1. *Neocosmospora vasinfecta* E. F. Smith; CBS 237.55.
2. *Neocosmospora africana* Von Arx; CBS 237.
3. *Neocosmospora* sp. isolated from soybean stem, Pietermaritzburg, South Africa. Referred to in the following text as 'isolate P'.

Cultures were maintained on 1.5% Difco malt agar and yeast-starch agar (Cooney & Emerson, 1964) at 25°C under intermittent illumination, 12 h/d, by near ultra violet light (NUV) fluorescent tubes (GEC F15T8/BLB). Isolate P was also maintained on Difco oatmeal agar.

The nuclear divisions leading to ascosporeogenesis were examined in all three isolates studied. Identical techniques were used for similar stages in the different isolates to ensure absolute comparability.

Nuclei were stained using the HCL-Giemsa techni-

que (Van Warmelo, 1971) and examined and photographed under bright field illumination with a yellow green filter.

RESULTS

Unless otherwise stated, all the following observations apply equally to all three examined specimens.

The earlier sexual stage seen was the multinucleate ascogonium (Figs 1, 2, 40, 83 & 84). The ascogonia varied in size and form from the highly nucleated, simple spherical ascogonium (Fig. 1) to the elongated, cylindrical ascogonium (Figs 83 & 84) and the complex convoluted ascogonium (Figs 2 & 40). The nuclei were small, densely stained and associated in pairs. At no stage was the mechanism of dikaryotization observed. Ascogonia were found in very young perithecia and were identified as ascogonia on the basis of the usually multinucleate condition with commonly, associated pairs of nuclei.

The only ascogenous hyphae seen were found in *Neocosmospora africana* (Fig. 41). These were short, indistinct and typically binucleate. After a very restricted growth they showed signs of crozier formation.

Crozier and young ascus formation

Binucleate pre-crozier were found in *N. africana* (Fig. 42) and isolate P (Fig. 85). These were rounded and did not yet show the characteristic curvature of the crozier. The binucleate condition was, however, an indication of their origin.

Typical binucleate croziers were found (Figs 3, 43 & 86). Their development into young asci followed the typical pattern (Figs 4, 44, 45, 46, 47, 87 & 88). Occasional large croziers were found (Fig. 5), but were not of unusual significance.

The young ascus enlarged and became cylindrical after karyogamy (Figs 48, 49 & 89) which gave rise to the diploid nucleus (Figs 6, 50 & 90).

The nuclei showed marked variations in appearance during karyogamy and the subsequent diplophase. At the conclusion of the conjugate division in the binucleate crozier the nuclei were small and intensely and uniformly stained. During karyogamy the nuclei no longer stained uniformly and showed fragments of linear bodies interpreted as partially condensed chromosomes. The nuclei in the terminal and basal cells remained unchanged. The diploid nuclei were less varied in appearance. A featureless uneven mass of chromatin, apparently surrounded by a nuclear membrane, was sometimes observed (Fig. 90). Older diploid nuclei showed differentiation (Figs 6 & 50).

Division 1

Nuclear divisions in the asci are numbered according to the system used by Singleton (1953).

During prophase of the first meiotic division the nuclei enlarged and were usually centrally placed in the ascus. There was very little differentiation of chromosomes at this stage (Figs 7 & 91) and the uninucleate basal and terminal cells of the crozier were often still present at the base of the ascus (Figs 50, 91 & 92).

At leptotene the chromosomes were readily distinguishable as long thin strands (Figs 8, 51 & 92). In Fig. 92 there is evidence of a nuclear membrane around the chromosome mass. Nucleoli were demonstrated in some leptotene nuclei (Fig. 51), but not in others (Fig. 8).

At zygotene the chromosomes were much more distinct, and thickenings and other details became visible. The nuclei also appeared to be larger than during leptotene, possibly due to a better spread of a less cohesive chromosomal mass during squashing of the asci.

Zygotene showed chromosomes which were identified as homologues by the similarities in the terminal chromomere patterns (Figs 9, 10, 52, 53 & 93). Chromosome pairs were seen in which synapsis was apparently completed while other chromosomes were only partially associated (Figs 52 & 93).

At pachytene the synapsed homologues were closely associated and were no longer distinguishable as chromosome pairs (Figs 11, 54 & 94). Occasionally fully synapsed pairs were found in which the two component chromosomes of the bivalent could be seen (Fig. 14). Nucleoli were only occasionally present during pachytene (Fig. 15).

Pachytene stages in which the chromosomes could be counted were found in *N. vasinfecta* (Figs 12 & 13) and isolate P (Figs 95 & 96). No countable stages were found in *N. africana*.

In *N. vasinfecta* (Figs 12 & 13) six chromosomes were counted and their lengths estimated. Centromeres could not be distinguished.

The estimated lengths of the six chromosomes, numbered in descending order of length (Singleton, 1953), were:

1 = 13,5 μm	2 = 7,5 μm	3 = 6,0 μm
4 = 5,25 μm	5 = 1,75 μm	6 = 1,5 μm

The lengths of chromosomes 5 and 6 were probably underestimated as the chromosomes appeared to have been compressed during squashing of the preparation.

Six chromosomes were also counted in isolate P (Figs 95 & 96). As in *N. vasinfecta*, no centromeres were distinguishable and the nucleolus had disappeared. The estimated lengths of the six chromosomes were:

1 = 25 μm	2 = 15 μm	3 = 12 μm
4 = 11 μm	5 = 8 μm	6 = 7 μm

Although there was little agreement between the estimated chromosome lengths of *N. vasinfecta* and isolate P, the relative lengths as given below agreed closely.

Relative chromosome lengths			
	<i>N. vasinfecta</i>	Isolate P	Difference
Chromosomes 1:2	1,80	1,67	0,13
Chromosomes 2:3	1,25	1,25	0,00
Chromosomes 3:4	1,14	1,09	0,05
Chromosomes 4:5	3,00	1,38	1,62
Chromosomes 5:6	1,17	1,14	0,03

Only in the case of the ratio of chromosomes 4 and 5 is there a marked difference between the two fungi. It was pointed out above, however, that the lengths of chromosomes 5 and 6 in *N. vasinfecta* were probably underestimated.

During diplotene the bivalents shortened and became fuzzy in outline (Fig. 97). Crossover points were seen as small loops in the contracted bivalents (Figs 16, 55 & 98). Late diplotene chromosomes were noticeably shorter than pachytene chromosomes (Fig. 99) and were also thinner.

In both *N. vasinfecta* and *N. africana* what appeared to be a ring chromosome was seen during diplotene (Figs 16 & 55). There was however, no evidence of a ring chromosome during pachytene.

Diakinesis showed no abnormal or unexpected

features (Figs 17, 56 & 100). The chromosomes were short, highly condensed and almost spherical. They could not be counted.

Metaphase I chromosomes were highly condensed, almost spherical and very short (Figs 18, 57 & 101). They were not arranged in a metaphase plate across the equatorial plane of the spindle, but appeared as a dense central aggregation of chromatin in the spindle. Spindles were sometimes clearly seen (Fig. 101), but were more frequently indistinct, their presence and orientation being indicated by diffraction lines in the cytoplasm of the ascus (Figs 57 & 58). Spindles were orientated along the long axis of the ascus (Figs 18 & 58), or at right angles to it (Figs 57 & 102), or obliquely (Fig. 101).

Chromosome counts at metaphase I were unreliable due to the close association of the chromosomes. Occasionally, however, fairly reliable counts could be made. In polar view (Fig. 102) six chromosomes were distinguished in isolate P, while the same number was seen in *N. africana* (Fig. 58).

In isolate P the chromosome count at metaphase I agreed with that made at pachytene. Although no countable pachytene stages were found in *N. africana*, the chromosome number at metaphase I was the same as that found in both *N. vasinfecta* and isolate P. Important also was the observation that, in *N. africana*, there appeared to be four large chromosomes and two smaller ones (Fig. 58), a situation similar to that found at pachytene in *N. vasinfecta*. In isolate P (Fig. 102) there were also size differences between the chromosomes but they were less marked.

It was impossible to estimate the chromosome sizes from metaphase I figures.

Separation of the chromosomes during anaphase I appeared to be sequential rather than synchronous and a number of different chromosome arrangements were seen. In *N. africana* a series of stages illustrating sequential separation were found. A stage was seen of the transition from metaphase I to anaphase I (Fig. 59) in which the arrangement of the chromosomes was virtually identical with one at metaphase I (Fig. 58). The only differences was that one or two bivalents had separated before the other chromosomes. A further stage was seen (Fig. 60) in which separation of the homologues had occurred with only slight movement of the chromosomes on the spindle. An even later stage was seen (Fig. 61) in which movement of the chromosomes had begun whilst maintaining a similar chromosomal arrangement.

Sequential rather than synchronous separation of bivalents was also seen in *N. vasinfecta* (Fig. 19) and isolate P (Fig. 103). Precocious chromosomes were linked to the median unseparated bivalents by thin spindle strands.

At mid anaphase I the condensed chromosomes were spread in a band along the spindle (Fig. 62) and individual chromosomes could not be distinguished. At late anaphase I the chromosomes had started to form terminal groups (Figs 20 & 104).

Telophase I nuclei were usually small, spherical and homogeneous. At early telophase I there were occasional lagging chromosomes (Figs 63 & 106). However, no case was seen in which any lagging chromosomes failed to be incorporated in the daughter nuclei. The reconstituted daughter nuclei rounded off at the conclusion of the division, connected only by the remains of the spindle (Figs 64 &

105). Discarded nucleoli were occasionally seen (Fig. 107).

At the conclusion of telophase I the nuclei entered interphase I. Generally this process was asynchronous and asci were found in which one nucleus was in interphase I while the sister nucleus was still in telophase I (Fig. 21).

Interphase I nuclei were larger than at telophase, approximately spherical and heterogeneous (Figs 22, 65 & 108). Individual chromosomes could not be distinguished, although nucleolus-like bodies were sometimes seen (Fig. 22).

Division II

Prophase II nuclei were less diffuse than at interphase I and stained intensely (Figs 23, 66 & 109). The chromosomes of *N. vasinfecta* and *N. africana* were short, whereas those of isolate P were indistinct. In *N. vasinfecta* nucleoli were seen in the nuclei (Fig. 23). Nucleoli were not seen in *N. africana* and isolate P.

Metaphase II was indistinct. At early metaphase the deeply-staining chromosomes were arranged centrally between the two centriolar plaques (Fig. 67). The chromosomes were so closely associated that counts were impossible (Figs 24, 68 & 110). Centriolar plaques were not always visible although spindles were sometimes seen (Fig. 110).

Anaphase II followed the same general pattern as anaphase I. Spindles were either parallel with (Fig. 69), or across (Figs 111 & 112) the long axis of the ascus. Sequential disjunction of the chromatids was once again suggested by the linear arrangement of chromosomes with interconnecting interzonal or spindle fibres.

Occasionally chromosomes were clearly delimited at anaphase II (Fig. 113). Six chromosomes were seen at this stage.

Telophase II nuclei (Figs 25, 70, 114 & 115) were identical with the telophase I nuclei. No lagging chromosomes or spindle bridges were seen at this stage.

Interphase II nuclei (Figs 26, 71 & 116) resembled the interphase I nuclei described. The four interphase II nuclei were commonly arranged as two adjacent pairs arranged symmetrically around the centre of the ascus (Figs 26 & 116).

Division III

Prophase III nuclei resembled the prophase II nuclei described. Initially long and diffuse, the chromosomes shortened and became intensely stained (Figs 27, 72, 117 & 118).

Prometaphase III stages showed short dense chromosomes (Figs 28 & 73) and occasional centriolar plaques (Fig. 73).

Metaphase III nuclei (Figs 29 & 119) resembled the metaphase II nuclei described. The arrangement of the four nuclei followed no regular pattern.

Anaphase III was seen only in isolate P (Figs 120 & 121) and was similar to the previously described anaphase stages. Divisions of the nuclei were not fully synchronous (Figs 120 & 121) and alignment of the spindles was variable.

Lagging chromosomes at late anaphase III/early telophase III were seen (Fig. 30) but these became incorporated into the reconstituted telophase III nuclei. Evidence for this was the absence of lagging chromosomes at late telophase. These nuclei (Figs 74

& 122) were similar to the telophase stages described, but could also be larger (Fig. 123).

Interphase III nuclei (Figs 31, 32, 75 & 124) resembled the nuclei seen at interphase I and II.

The earliest signs of spore delimitation were seen at interphase III (Fig. 31). There were, however, interphase III stages with no signs of incipient cytoplasmic cleavage (Figs 75 & 124), whereas in some asci well developed cytoplasmic cleavages were seen (Figs 32 & 76).

Division IV

Prophase IV nuclei (Figs 33, 77 & 125) were similar to the prophase II and III nuclei described. In all isolates asci in prophase IV without any signs of incipient cytoplasmic cleavage were found (Figs 33, 77 & 125), whereas other asci also in prophase IV were found in which well defined spore initials were clearly visible (Figs 78 & 126).

Prometaphase IV (Fig. 127) was found in isolate P only and was similar to prometaphase stages of the preceding divisions. Metaphase IV and anaphase IV stages were not found in any of the isolates.

Telophase IV nuclei (Figs 34, 35, 79, 128, 129 & 130) were identical with the previously described telophase stages. Interphase IV nuclei (Figs 37 & 131) also resembled similar stages in the preceding divisions.

Neocosmospora vasinfecta differed from the other isolates with respect to spore delimitation. Whereas the spores in *N. africana* and isolate P were invariably delimited before telophase IV (Figs 79 & 129), occasional asci were found in *N. vasinfecta* which contained sixteen nuclei not separated by cytoplasmic cleavage planes (Figs 34 & 35). Such asci were large and commonly globose. Normal cylindrical asci with cytoplasmic cleavage planes at this stage were common (Fig. 36). As the mature spores of *N. vasinfecta* were always found in asci of normal size, it is postulated that the large uncleaved 16-nucleate asci degenerated without delimiting spores. How, why and when this occurred could not be determined.

Following division IV the eight ascospores in an ascus were binucleate. Nuclei in spores of increasing age, as determined from the increasing thickness of the spore wall, showed a progressive condensation (Figs 38, 39, 80, 81, 82, 132, 133 & 134). Nuclei in mature spores were thus condensed and intensely stained.

Ascus proliferation

Fusion of the terminal cell of the crozier with the basal cell was commonly seen in *N. africana* and isolate P, but was less common in *N. vasinfecta*. A single ascogenous hypha could therefore give rise to further asci.

DISCUSSION

The mechanism of dikaryotization was not elucidated. As no signs of receptive hyphae or spermatium formation were seen, the most likely mechanism is random somatogamy. As all three isolates are homothallic this mechanism is not unlikely. Doguet's (1956) observation of defined ascogonial structures in *Neocosmospora vasinfecta* and *N. africana* was thus not confirmed.

It is well established that the sexual nuclear division in the ascus is an ordered process corresponding to gametogenesis in higher organisms. The division can therefore correctly be called meiotic.

Sequence of nuclear divisions in the ascus

The sequence of nuclear divisions leading to the formation of mature ascospores was normal in all three isolates. This confirms the statement by Doguet (1956) that ascosporeogenesis in *N. vasinfesta* and *N. africana* follows the established pattern.

Homology of meiotic prophase chromosomes

Zygotene chromosome pairs were seen in all isolates in which synapsis was apparently completed while other chromosome pairs were only partially associated. Homology of certain chromosomes was deduced from the similarities in chromomere pattern. Synaptic failure could either indicate slow pairing or non-homology of chromosome pairs or areas. Only in *N. vasinfesta* was one configuration seen (Figs 12 & 13) which suggested incomplete synapsis. This could, however, have been due to a chromosome abnormality not necessarily indicative of non-homology.

Furthermore, non-homologous chromosomes in the karyotype would result in pachytene associations showing incomplete bivalent formation. No post-pachytene stages showing abnormalities were, however, observed. All the available evidence therefore indicates that, although synapsis during zygotene is rather slow, there is complete homology of all chromosomes pairs.

The chromosome number of each of the three isolates was determined at several stages during ascosporeogenesis. Six chromosomes were counted in all cases. This number agrees with the counts made during mitotic divisions (Van Warmelo, 1977).

The lengths of the pachytene chromosomes were estimated in *N. vasinfesta* and isolate P. Although chromosome lengths at pachytene vary considerably with the structure of the bivalent and the degree of squashing during preparation of the material, it is reasonable to assume that all chromosomes in a single nucleus will be squashed to very much the same extent. Relative chromosome lengths are therefore probably more important than absolute lengths.

The relative lengths of the chromosomes of *N. vasinfesta* and isolate P are almost identical, even though their estimated absolute lengths are markedly dissimilar. If it is assumed that chromosomes 5 and 6 in *N. vasinfesta* (Fig. 13) became distorted during squashing, there is a close similarity between the karyotypes of these isolates.

Although no countable pachytene stages were seen in *N. africana*, it is significant that four long and two short chromosomes were present at metaphase I (Fig. 58). As the chromosomes were highly condensed the relative lengths could not be estimated. It is, therefore, postulated that the chromosome ratios of *N. africana* at least approximate the ratios determined for *N. vasinfesta* and isolate P.

Metaphase/anaphase

Even though spindles were not always seen, evidence for their presence was provided by the presence of centriolar plaques and also diffraction patterns in the cytoplasm around the chromosomes. When spindles were seen, their size and orientation agreed with the observed diffraction patterns. Spindles are presumably present during nuclear divisions, although they cannot always be demonstrated.

Metaphase separation is essentially similar in all the isolates. It is suggested that separation of chromosome pairs/chromatids is sequential rather than synchronous. These results are in accordance

with the statement by Olive (1965) that asynchronous anaphase separation in the ascus appears to be the rule in the fungi.

Although anaphase separation was asynchronous, there was no evidence of irregular chromosome disjunction. This was deduced from the absence of lagging chromosomes at late telophase or interphase, indicating complete reconstruction of the daughter nuclei, the constancy of chromosome numbers and the phenotypic constancy of the cultures. It can, therefore, be assumed that the regularity of karyotype and genome replication is high.

Ascospore delimitation

The occasional absence of cytoplasmic cleavage planes at telophase IV and interphase IV might be regarded as an important feature of *Neocosmospora vasinfesta*, and an important difference between it and *N. africana* and isolate P. However, the fact that the 16-nucleate uncleaved asci were not seen to form ascospores and apparently degenerated, reduces the emphasis that should be placed on this characteristic as taxonomic criterion. Although it is a difference between *N. vasinfesta* and the other isolates, it does not seem to be an important one.

There are, therefore, no significant differences between *N. vasinfesta* E. F. Smith, *N. africana* Von Arx and 'isolate P' and the former two species cannot be distinguished on the basis of sexual chromosomal data.

ACKNOWLEDGEMENTS

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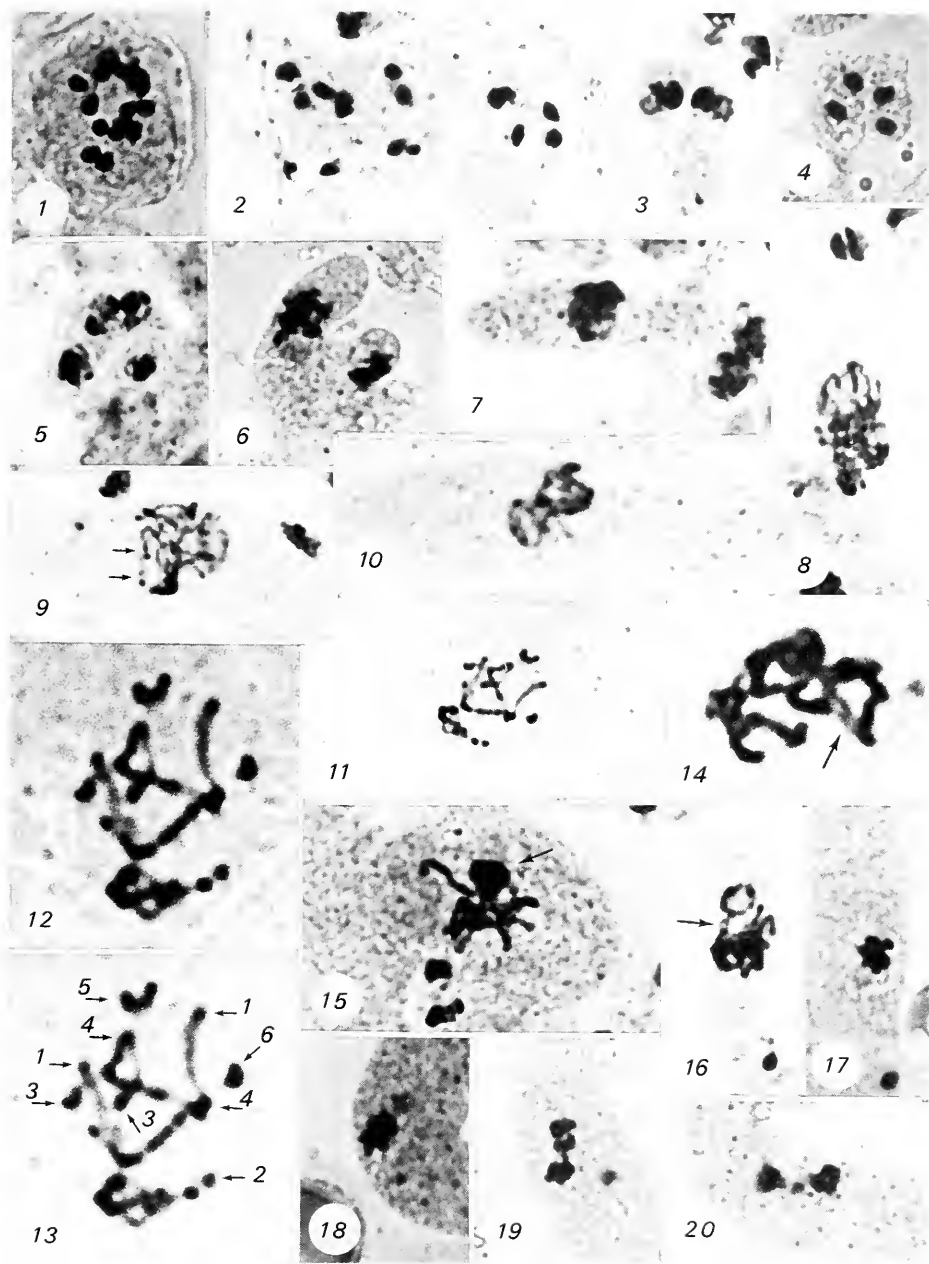
UITTREKSEL

'n Swamsort afkomstig van sojaboonweefsel het duidelike ooreenkomste getoon met twee bestaande *Neocosmospora* soorte, t.w. *N. vasinfesta* E. F. Smith en *N. africana* Von Arx. Die geslagtelike kerdelings in outentieke kulture van hierdie twee soorte en die plaaslike isolaat is ondersoek om vas te stel of daar verskille tussen die kulture was. Geen betekenisvolle verskille is waargeneem nie. Ses chromosome is in alle gevalle aangetref en hulle relatiewe lengtes was blykbaar dieselfde. Daar was geen tekens van aneuploidie of onreëlmatige vorming van dogterkerne nie. Delings is dus tipies meioties en lei tot vorming van tweekernige homokariotiese askospore.

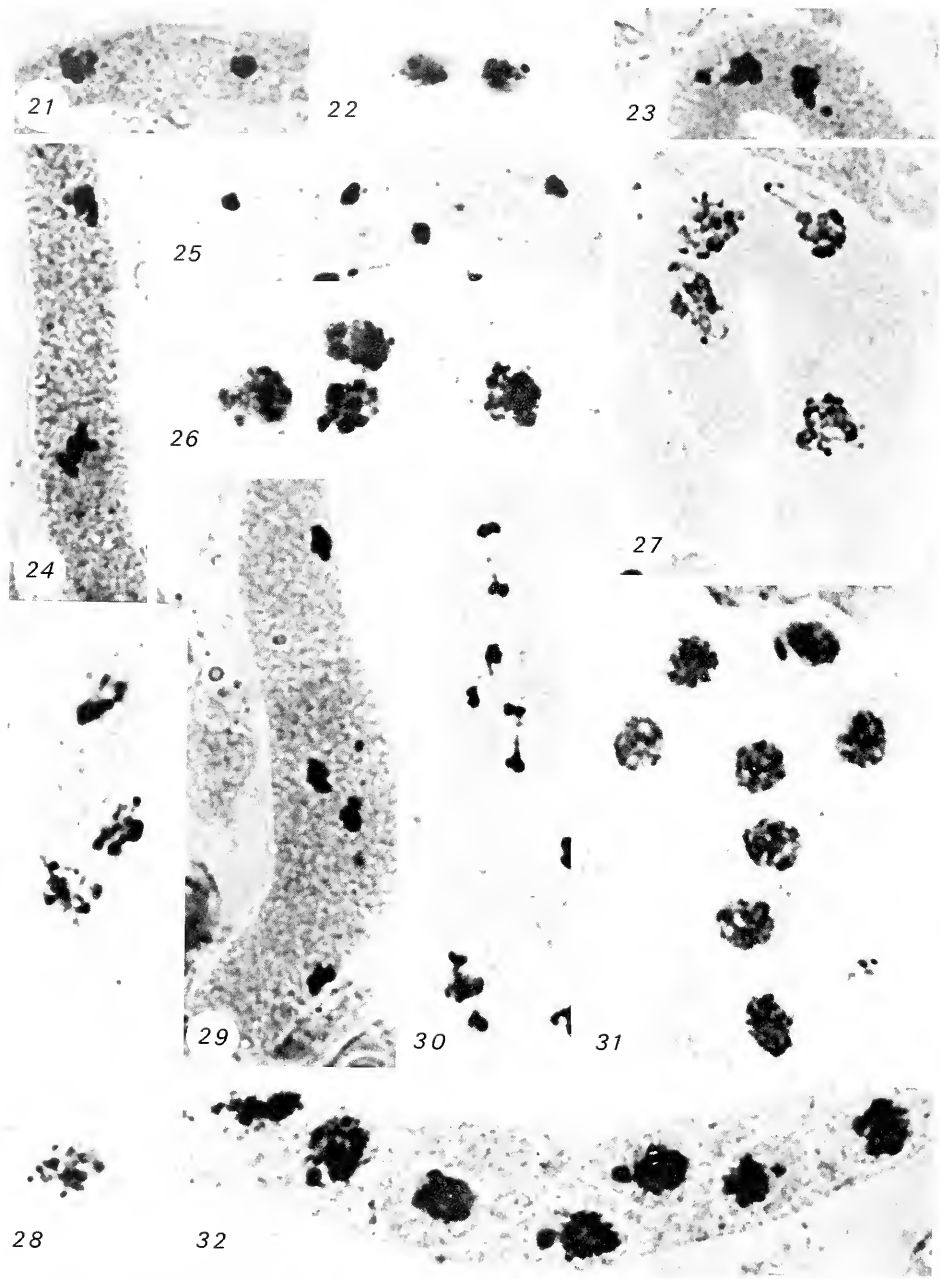
REFERENCES

- ALDRICH, H. C., 1967. The ultrastructure of meiosis in three species of *Physarum*. *Mycologia* 59: 127-148.
- BARRY, E. G., 1967. Chromosome aberrations in *Neurospora*, and the correlation of chromosomes and linkage groups. *Genetics*, Princeton 55: 21-32.
- COONEY, D. G. & EMERSON, R., 1964. *Thermophilic fungi*. London: W. H. Freeman. 188 pp.
- DOGUET, G., 1956. Morphologie et organogénie du *Neocosmospora vasinfesta* E. F. Smith et du *Neocosmospora africana* Von Arx. *Annls Sci. nat. Bot. ser. 11*, 17: 353-370.
- FERRY, R., 1900. Un nouveau genre de champignon (*Neocosmospora*) qui constitue un redoutable fléau pour le cotonnier, la citrouille et la Vigna sinensis. *Revue Mycol.* 22: 121-124.
- FURTADO, J. S., 1970. Ascyl cytology of *Sordaria brevicollis*. *Mycologia* 62: 453-461.
- HUFFMAN, D. M., 1968. Meiotic behavior in the mushroom *Collybia maculata* var. *scorzoneræ*. *Mycologia* 60: 451-456.
- HUGUENIN, B. & BOCCAS, B., 1970. Etude de la Caryocinèse chez le *Phytophthora parasitica* Dastur. *C. R. Acad. Sci. Paris, sér. D*, 271: 660-663.

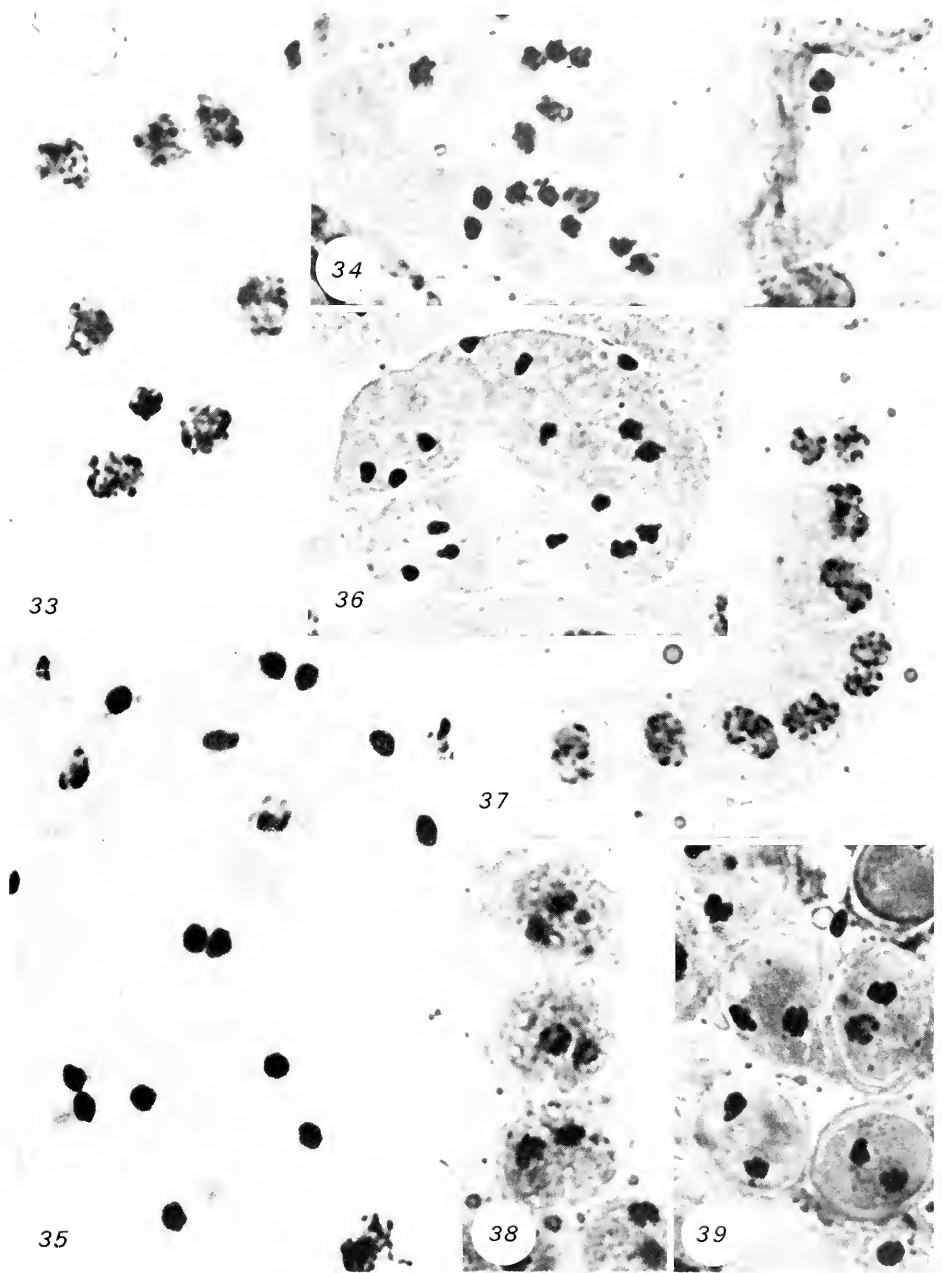
- KNOX-DAVIES, P. S. & DICKSON, J. G., 1960. Cytology of *Helminthosporium turcicum* and its ascigerous stage, *Trichometasphaeria turcica*. *Ann. J. Bot.* 47: 328–339.
- LU, B. C., 1966. Fine structure of meiotic chromosomes of the Basidiomycete *Coprinus lagopus*. *Expl Cell Res.* 43: 224–227.
- LU, B. C., 1967a. The course of meiosis and centriole behaviour during the ascus development of the Ascomycete *Gelasinospora calospora*. *Chromosoma* 22: 210–226.
- LU, B. C., 1967b. Meiosis in *Coprinus lagopus*: a comparative study with light and electron microscopy. *J. Cell Sci.* 2: 529–536.
- MOREAU, C. & MOREAU, MIREILLE., 1950. *Neocosmospora vasinfecta* E. F. Smith. Faux wilt du cotonnier. Fiches de Phytopathologie. *Revue Mycol.* 15, Suppl. 2, 5 p.
- OLIVE, L. S., 1953. The structure and behavior of fungus nuclei. *Bot. Rev.* 19: 439–586.
- OLIVE, L. S., 1965. Nuclear behavior during meiosis. Chapter 7. In G. C. Ainsworth & Sussman, A. S. (eds), *The fungi. An advanced treatise*. Vol. 1. London: Academic Press.
- RAJENDREN, R. B., 1967. A new type of nuclear life cycle in *Hemileia vastatrix*. *Mycologia* 59: 279–285.
- RAO, V. R. & MUKERJI, K. G., 1970. Cytology of the ascus in *Ascotricha guamensis*. *Mycologia* 62: 301–306.
- ROGERS, J. D., 1964. *Hypoxylon pruinautum*: the chromosome number. *Mycologia* 56: 369–373.
- ROGERS, J. D., 1965. *Hypoxylon fuscum*. I. Cytology of the ascus. *Mycologia* 57: 789–803.
- ROGERS, J. D., 1967. *Hypoxylon multifforme*: cytology of the ascus. *Mycologia* 59: 295–305.
- ROGERS, J. D., 1968a. Nuclear phenomena in the ascospores of *Hypoxylon punctulatum*. *Can. J. Bot.* 46: 865–866.
- ROGERS, J. D., 1968b. *Xylaria curta*: cytology of the ascus. *Can. J. Bot.* 46: 1337–1340.
- ROGERS, J. D., 1968c. *Hypoxylon deustum*: the chromosome number. *Mycopath. Mycol. appl.* 35: 249–255.
- ROGERS, J. D., 1971. Observations on the ascogenous system of *Hypoxylon microplacum*. *Can. J. Bot.* 49: 1075–1077.
- SEAYER, F. J., 1909. The Hypocreales of North America — I. *Mycologia* 1: 41–76.
- SINGLETON, J. R., 1953. Chromosome morphology and the chromosome cycle in the ascus of *Neurospora crassa*. *Am. J. Bot.* 40: 124–144.
- SWANSON, C. P., 1968. *Cytology and cytogenetics*. London: Macmillan 596 pp.
- UDAGAWA, S., 1963. *Neocosmospora* in Japan. *Trans. Mycol. Soc. Jap.* 4: 121–125.
- UECKER, F. A., 1967. *Stephensia shanori*. I. Cytology of the ascus and other observations. *Mycologia* 59: 819–832.
- VAN WARMELO, K. T., 1966. The cytology of *Mycosphaerella pinodes*. *Bothalia* 9: 195–202.
- VAN WARMELO, K. T., 1971. Somatic nuclear division in *Stemphylium botryosum*. *Bothalia* 10: 329–334.
- VAN WARMELO, K. T., 1976. Scanning electron microscopy of *Neocosmospora* ascospores. *Mycologia* 68: 1181–1187.
- VAN WARMELO, K. T., 1977. Asexual nuclear division in *Neocosmospora*. *Bothalia* 12: 247–250.
- VON ARX, J. A., 1955. Ein neuer Ascomycet aus Afrika. *Antonie van Leeuwenhoek* 21: 161–165.
- WELLS, K., 1970. Light and electron microscopic studies of *Asco-bolus stercorarius*. I. Nuclear divisions in the ascus. *Mycologia* 62: 761–790.
- WOO, J. Y. & PARTRIDGE, A. D., 1969. The life history and cytology of *Rhytisma punctatum* on big leaf maple. *Mycologia* 61: 1085–1095.
- ZICKLER, DENISE., 1970. Division spindle and centrosomal plaques during mitosis and meiosis in some Ascomycetes. *Chromosoma* 30: 287–304.



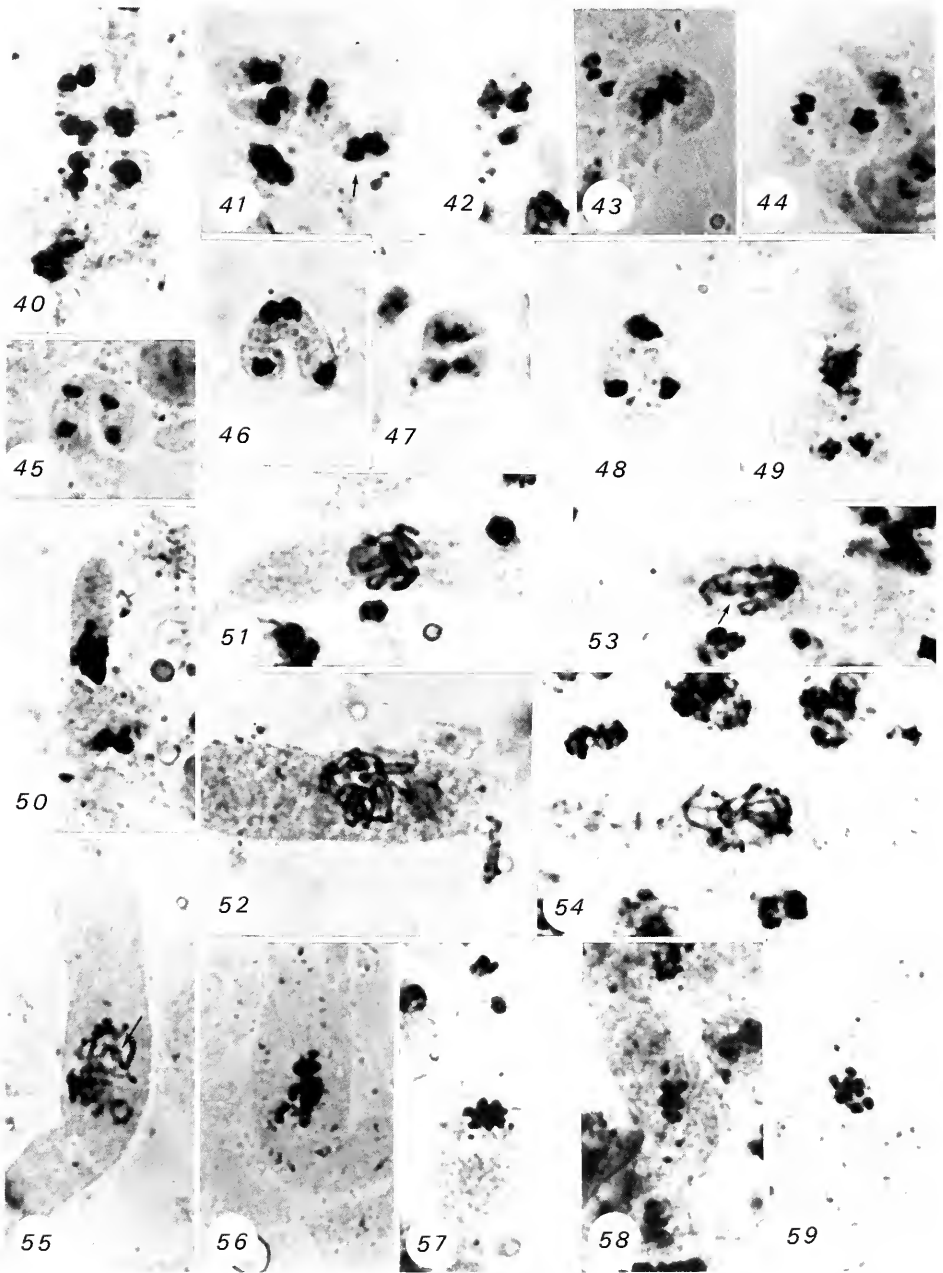
FIGS 1–20.—Meiosis in *Neocosmospora vasinfecta*; $\times 2,000$ unless otherwise stated. 1, spherical multinucleate ascogonium; 2, morphologically complex multinucleate ascogonium; 3, binucleate crozier; 4, tetranucleate crozier; 5, tetranucleate crozier; 6, crozier after karyogamy; 7, beginning of prophase I; 8, leptotene; 9, zygotene; 10, zygotene/pachytene; 11, pachytene; 12, pachytene; 13, pachytene with numbered chromosomes, $\times 4,000$; 14, pachytene showing bivalent structure, $\times 4,000$; 15, late pachytene; 16, diplotene; 17, diakinesis; 18, metaphase I; 19, early anaphase I; 20, mid anaphase I.



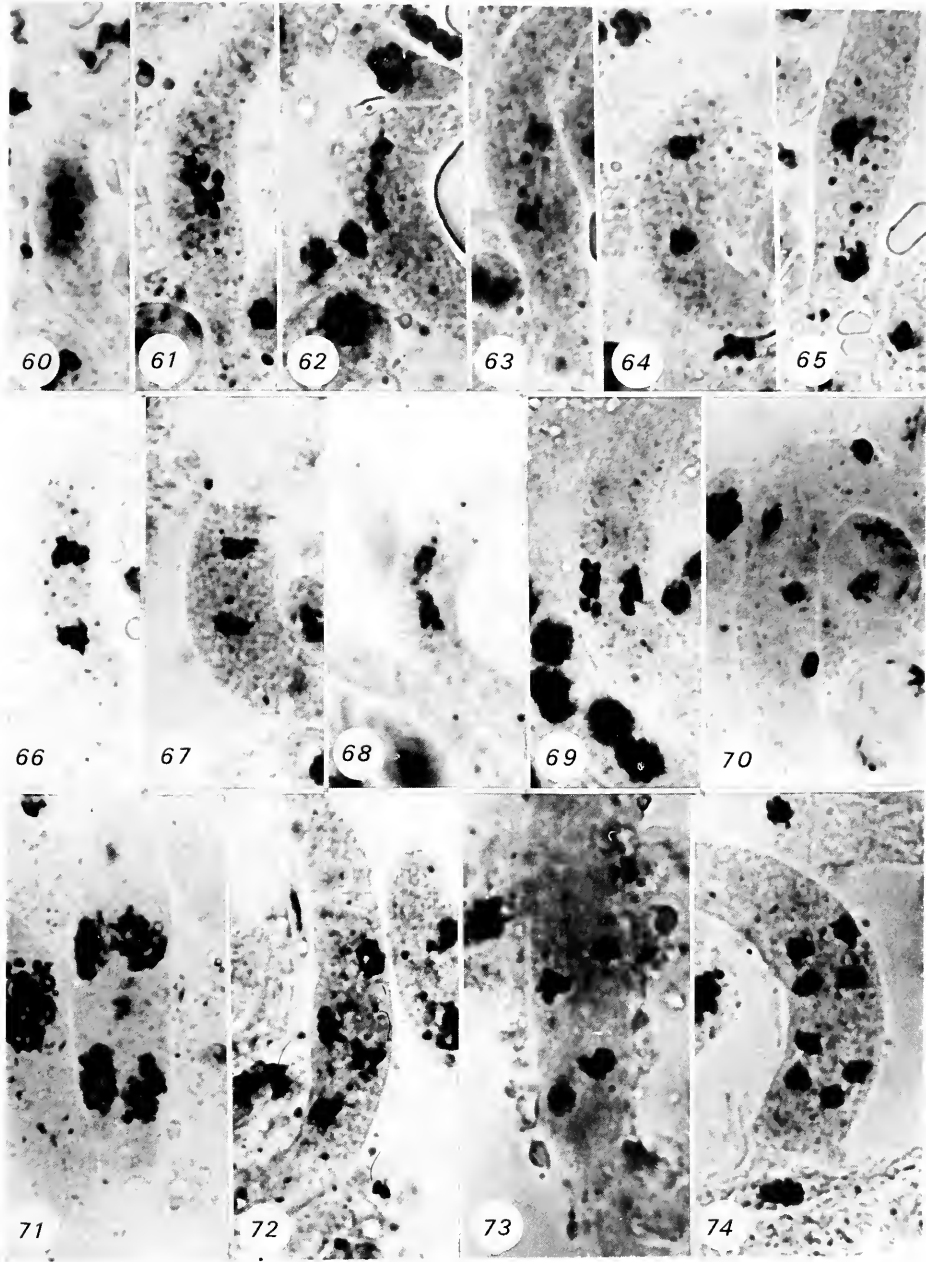
FIGS 21–32.—Meiosis in *Neocosmospora vasinfecta*: $\times 2\,000$. 21, telophase I; 22, interphase I; 23, prophase II; 24, metaphase II; 25, telophase II; 26, interphase II; 27, prophase III; 28, prometaphase III; 29, metaphase III; 30, anaphase/telophase III; 31, interphase III; 32, interphase III in delimited ascospores.



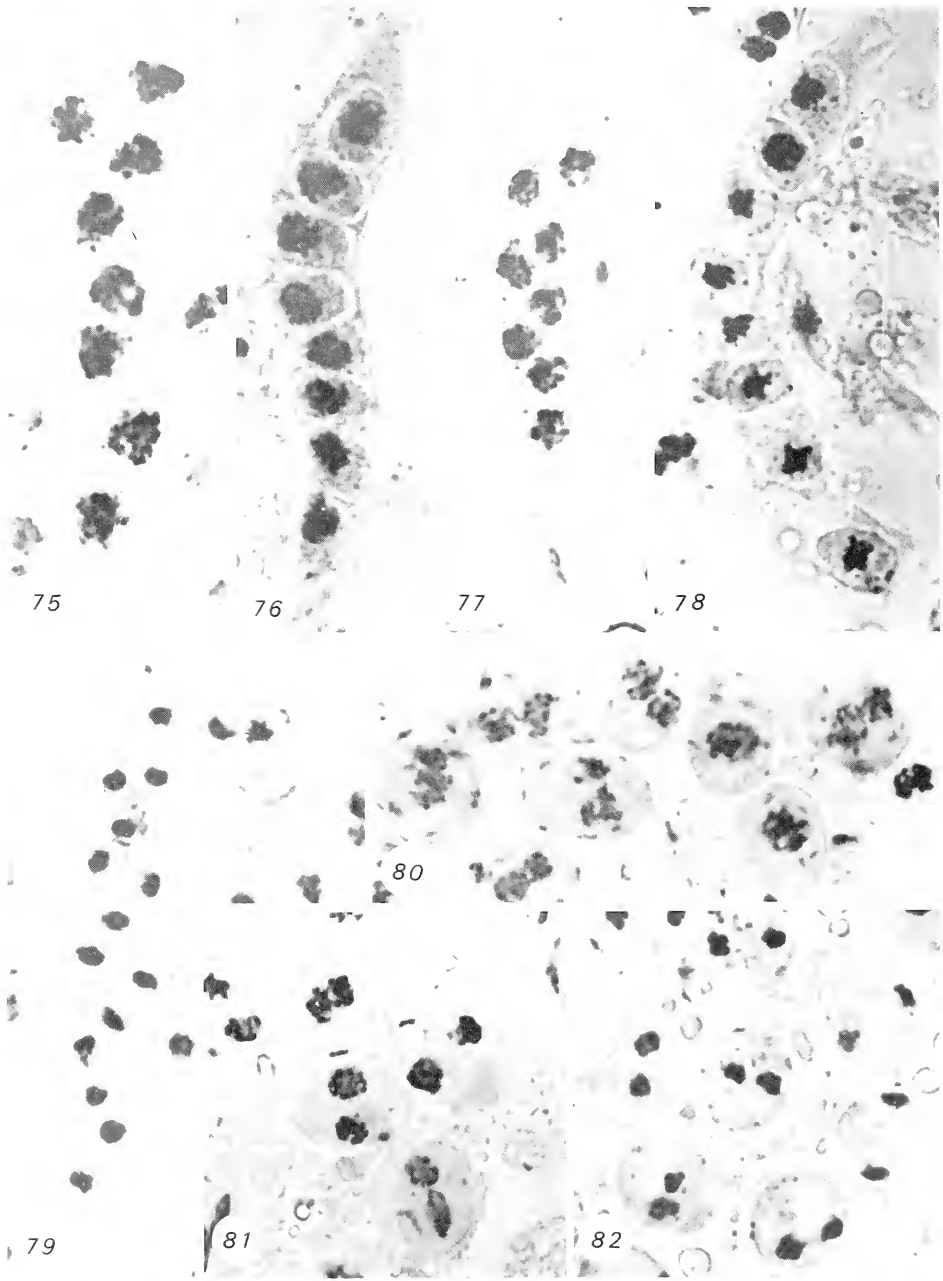
FIGS 33–39.—Meiosis in *Neocosmospora vasinfecta*: $\times 2\,000$. 33, prophase IV; 34, prophase IV without spore delimitation; 35, telophase IV; 36, telophase IV; 37, interphase IV; 38, mature binucleate ascospores; 39, mature binucleate ascospores.



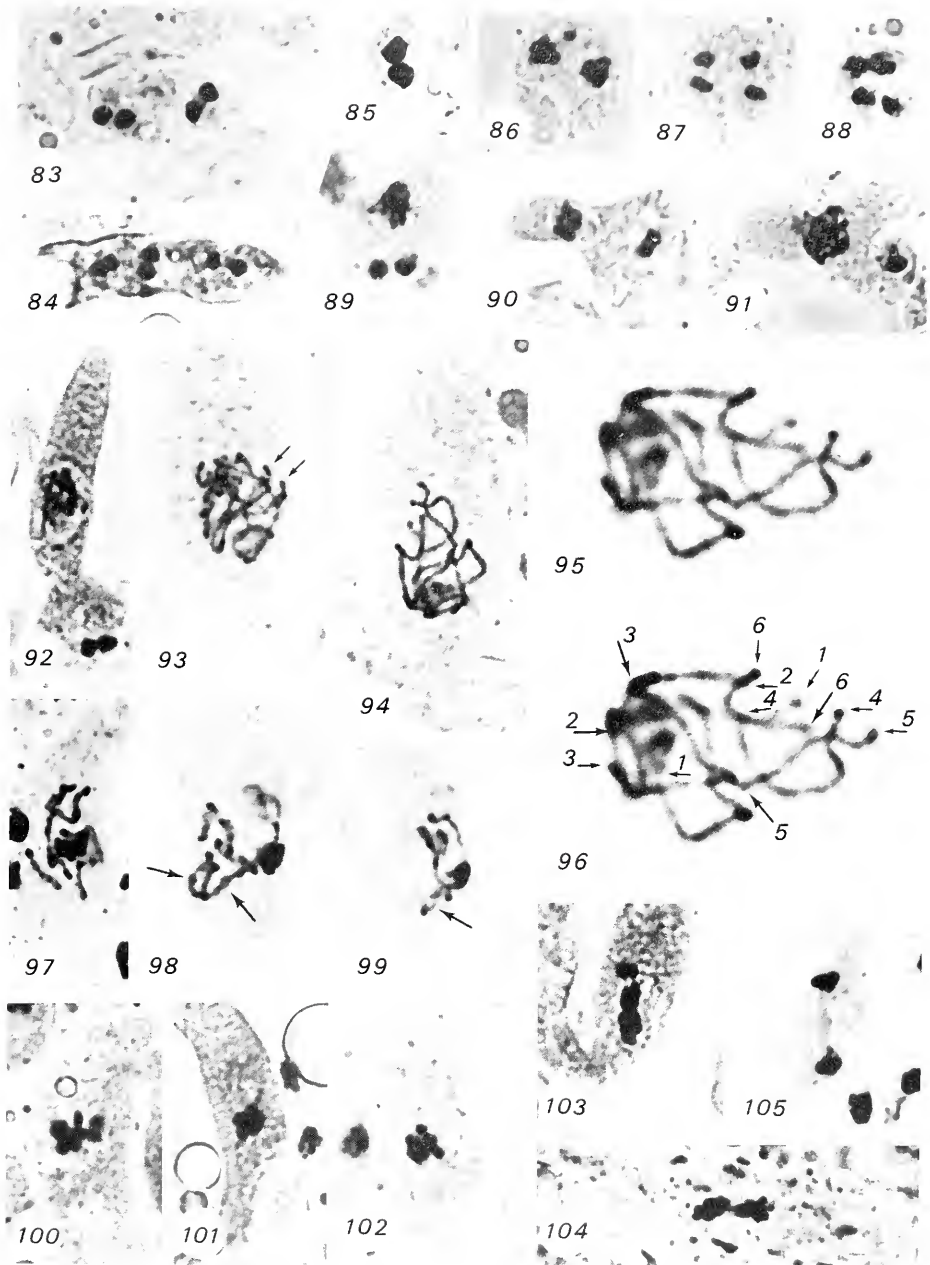
FIGS 40–59.—Meiosis in *Neocosmospora africana*: $\times 2\,000$. 40, ascogonium with paired nuclei; 41, ascogenous hypha; 42, binucleate pre-crozier; 43, binucleate crozier; 44, nuclear division in the binucleate crozier; 45, tetranucleate crozier after nuclear division; 46 tetranucleate crozier; 47, crozier after septum formation; 48, karyogamy in the young ascus; 49, diploid nucleus in the young ascus; 50, beginning of prophase I; 51, leptotene; 52, zygotene; 53, zygotene/pachytene; 54, pachytene; 55, diplotene; 56, diakinesis; 57, metaphase I with transverse spindle; 58, metaphase I with longitudinal spindle; 59, metaphase/anaphase I.



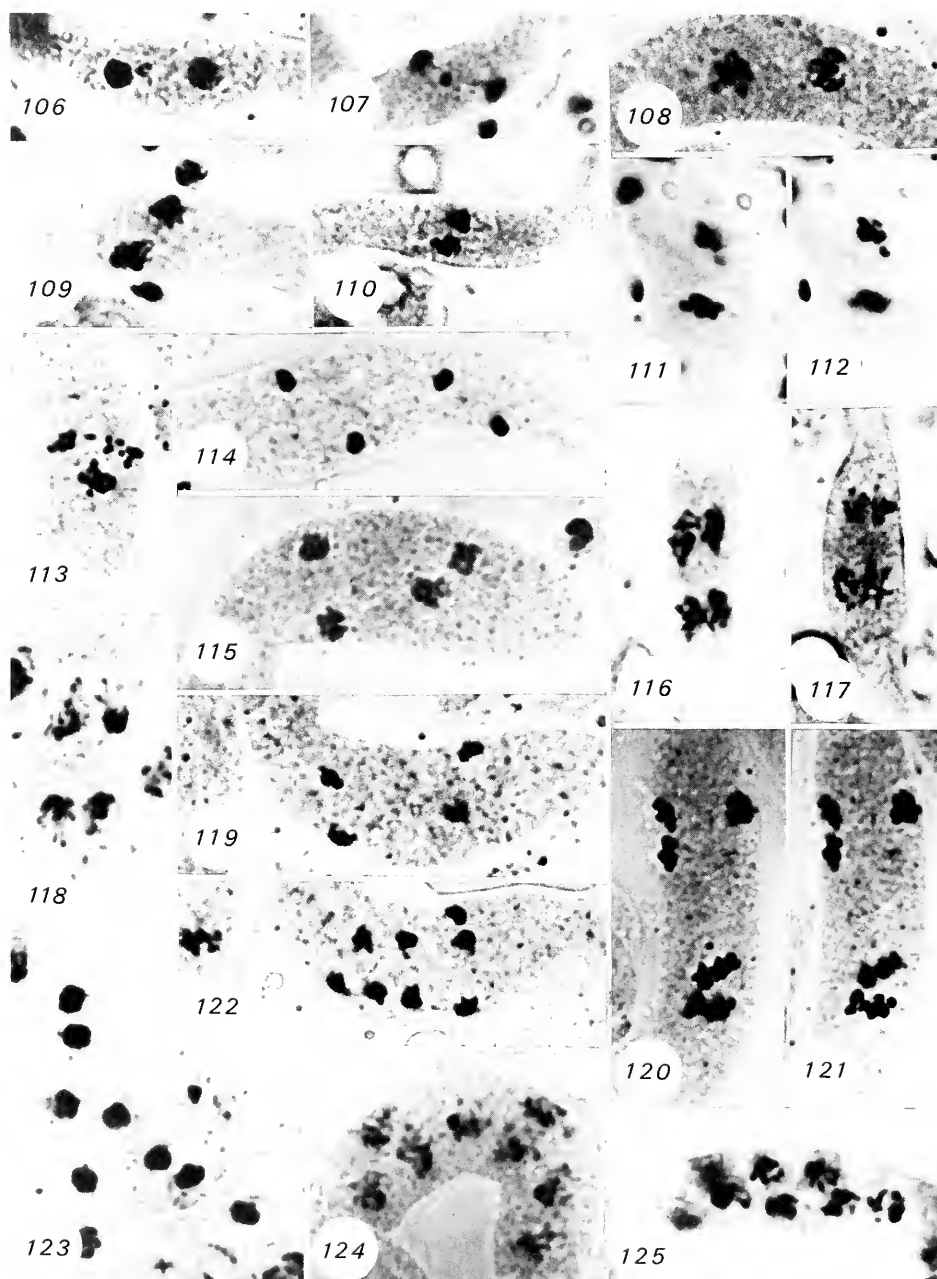
FIGS 60-74.—Meiosis in *Neocosmospora africana*: $\times 2\,000$. 60, early anaphase I; 61, anaphase I; 62, anaphase I; 63, anaphase/telophase I; 64, telophase I; 65, interphase I; 66, prophase II; 67, early metaphase II; 68, late metaphase II; 69, anaphase II; 70, telophase II; 71, interphase II; 72, prophase III; 73, prometaphase III; 74, telophase III.



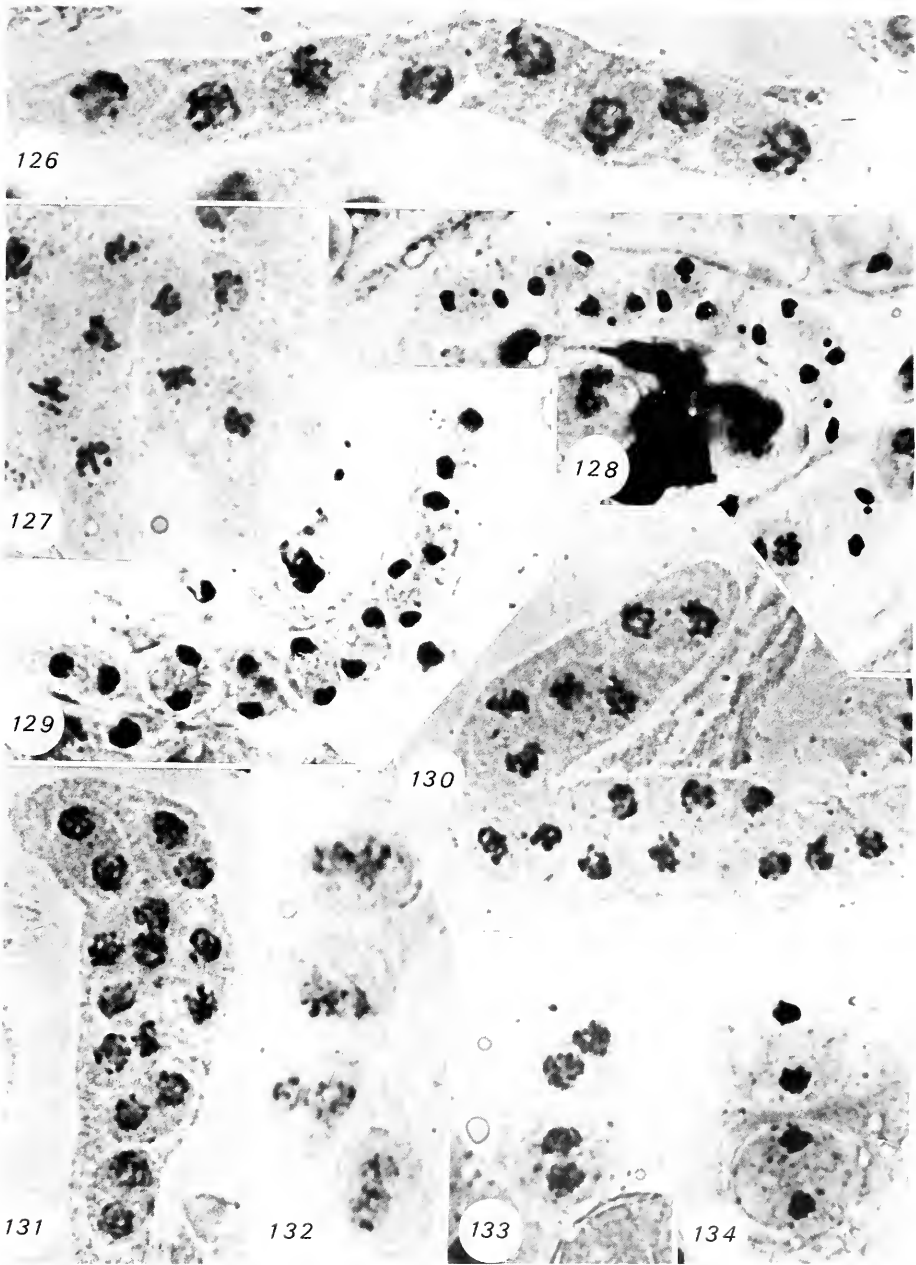
FIGS 75-82.—Meiosis in *Neocosmospora africana*: $\times 2\,000$. 75, interphase III before spore delimitation; 76, interphase III before spore delimitation; 77, early prophase IV; 78, prophase IV; 79, telophase IV; 80, interphase in binucleate ascospores; 81, interphase in binucleate ascospores; 82, interphase in binucleate ascospores.



FIGS 83–105.—Meiosis in *Neocosmospora* isolate P: $\times 2\,000$ unless otherwise stated. 83, ascogonium with two nuclear pairs; 84, ascogonium with three nuclear pairs; 85, binucleate pre-crozier; 86, binucleate crozier; 87, tetranucleate crozier after nuclear division; 88, tetranucleate crozier; 89, karyogamy in the young ascus; 90, diploid nucleus in the young ascus; 91, beginning of prophase I; 92, leptotene; 93, zygotene; 94, pachytene; 95, pachytene, $\times 4\,000$; 96, pachytene with numbered chromosomes, $\times 4\,000$; 97, pachytene/diplotene; 98, diplotene; 99, late diplotene; 100, diakinesis; 101, metaphase I; 102, metaphase I in polar view; 103, anaphase I; 104, late anaphase I; 105, telophase I.



FIGS 106–125.—Meiosis in *Neocosmospora* isolate P: $\times 2\,000$. 106, telophase I with slow chromosome; 107, telophase I with residual nucleolus; 108, interphase I; 109, prophase II; 110, metaphase II; 111, metaphase II; 112, anaphase II; 113, metaphase/anaphase II; 114, telophase II; 115, late telophase II; 116, interphase II; 117, early prophase III; 118, prophase III; 119, metaphase III; 120, anaphase III; 121, anaphase III; 122, telophase III; 123, large telophase III nuclei; 124, interphase III; 125, prophase IV.



FIGS 126-134.—Meiosis in *Neocosmospora* isolate P: $\times 2\,000$. 126, prophase IV with spore delimitation; 127, prometaphase IV; 128, telophase IV with residual median nucleoli; 129, telophase IV; 130, late telophase IV; 131, interphase IV; 132, interphase in binucleate ascospores; 133, interphase in binucleate ascospores; 134, interphase in binucleate ascospores.

Miscellaneous notes on the genus *Pelargonium*

J. J. A. VAN DER WALT* and P. J. VORSTER*

ABSTRACT

It is pointed out that the name sect. *Pelargium* DC. must be replaced by sect. *Pelargonium*, and *Pelargonium cardiophyllum* Harv. (1860) by *P. setulosum* Turcz. (1858); *P. mossambicense* Engl. is reported as a new record for the Transvaal; a new name *P. ternifolium* Vorster is given to *P. trifoliatum* Harv., nom. illeg.; and the typification of *P. multifidum* Harv., *P. plurisetum* Salter, *P. dolomiticum* Knuth and *P. dasyphyllum* E. Mey. ex Knuth is discussed.

NOTES DIVERSES SUR LE GENRE PELARGONIUM

Il est souligné que le nom sect. *Pelargium* DC. doit être remplacé par sect. *Pelargonium*, et *Pelargonium cardiophyllum* Harv. (1860) par *P. setulosum* Turcz. (1858); *P. mossambicense* Engl. est rapporté comme un nouvel enregistrement pour le Transvaal; un nouveau nom, *P. ternifolium* Vorster est donné à *P. trifoliatum* Harv. nom. illeg.; et l'établissement de types de *P. multifidum* Harv., *P. plurisetum* Salter, *P. dolomiticum* Knuth et *P. dasyphyllum* E. Mey. ex Knuth est discuté.

CORRECT NAME OF THE TYPE SECTION OF THE GENUS *PELARGONIUM*

The genus *Pelargonium* L'Hérit. was typified** by Van der Walt in J1 S. Afr. Bot. 45: 377 (1979), who chose *P. cucullatum* (L.) L'Hérit. (*Geranium cucullatum* L.) as the lectotype species. The section containing this species was placed as sect. *Pelargium* DC., Prodr. 1: 658 (1824) and this was followed by Harvey in Fl. Cap. 1: 301 (1860), Knuth in Pflanzenr. 4, 129: 455 (1912) and Van der Walt, *Pelargoniums* S. Afr. xiv (1977). According to Art. 22 of the Code, this section, containing the type species, must be referred to as *Pelargonium* L'Hérit. sect. *Pelargonium*.

PELARGONIUM MOSSAMBICENSE ENGL., NEW TO THE FLORA OF SOUTHERN AFRICA REGION

Pelargonium mossambicense Engl., Pflanzenw. Ost.-Afr. C: 225 (1895) has been known up to now from only a few collections on the Zimbabwe side of the mountains bordering Zimbabwe and Mozambique, and from the type collection made at Gorongosa in Mozambique in 1884–1885. It can now be announced that it also occurs in the Transvaal, having been found ca. 1.6 km east of Pilgrim's Rest on the road to Graskop (Codd 9797 in K!) and at Pilgrim's Rest (Rogers 23257 in BOL!). These records extend the known distribution of this species southwards by about 700 km. This distribution pattern, with populations widely separated by the broad Limpopo Valley, with small relic populations in the south, is shared by several species, for example the ferns *Pyrrosia schimperana* (Mett.) Alston [cf. Vorster in Bothalia 11: 287 (1974)] and *Selaginella imbricata* (Forssk.) Spring ex Decne. [op cit. 12: 259 (1977)], *Leucospermum saxosum* S. Moore [cf. Rourke in Flower. Pl. Afr. 41: t. 1633 (1971)] and

Aloe swynnertonii Rendle [cf. Reynolds, Aloes S. Afr. 220–222 (1950) as *A. chimanimaniensis*].

NEW NAME FOR *PELARGONIUM TRIFOLIATUM* HARV.

***Pelargonium ternifolium* Vorster, nom. nov.**

P. trifoliatum Harv. in Fl. Cap. 1: 271 (1860); Knuth in Pflanzenr. 4, 129: 351 (1912); non Sweet (1926); nec *P. trifoliatum* (Eckl. & Zeyh.) Steud. (1841). Type: 'Cape, Klein Drakenstein, Stell.' (Stellenbosch), Drège 7497 (K!; L!; P!; S!; W!).

P. CARDIOPHYLLUM HARV. VERSUS *P. SETULOSUM* TURCZ.

P. cardiophyllum Harv. was described in Fl. Cap. 1: 284 (1860), based on Ecklon & Zeyher 601 and Zeyher 2084. The name was subsequently wrongly upheld by Knuth in Pflanzenr. 4, 129: 389 (1912), who placed the earlier name, *P. setulosum* Turcz. in Bull. Soc. nat. Moscow 31: 422 (1858), based on Zeyher 2084, in synonymy. The latter is the correct name for this species.

Earlier, Ecklon & Zeyher, Enum. 1: 77 (1835), had wrongly associated their specimen Ecklon & Zeyher 601 with *Geranium elegans* Andr., Bot. Rep. 1: t. 28 (1799), when they effected the combination *Eumorpha elegans* (Andr.) Eckl. & Zeyh.

Harvey (l.c.) also described a variety *laciniatum*, having the 'leaves 3-lobed, the lobes lacinate and toothed'. However, both undivided and deeply lobed leaves may occur on the same plant and, with our present knowledge of the species, it does not appear justified to recognize the variety as a separate entity.

***Pelargonium setulosum* Turcz.** in Bull. Soc. nat. Moscow 31: 422 (1858). Type: Cape, 'C, b. spei', Zeyher 2084 (? MW, holo.; G!; K!; PRE, 2 sheets!; S!; W!; WU!; Z!).

Eumorpha elegans sensu Eckl. & Zeyh., Enum. 1: 77 (1835), as to Ecklon & Zeyher 601, non (Andr.) Eckl. & Zeyh. l.c. [*Geranium elegans* Andr., Bot. Rep. 1: t. 28 (1799)], nec *Pelargonium elegans* (Andr.) Willd., Sp. Pl. ed. 4, 3: 655 (1800).

P. cardiophyllum Harv. in Fl. Cap. 1: 284 (1860); Knuth in Pflanzenr. 4, 129: 389 (1912), syn. nov. Syntypes: Cape, 'Rocky mountain sides, above the Baths, and Baviansberg, Gnadenhal', Ecklon & Zeyher 601 (S!; SAM!); 'River Zonderende', Zeyher 2084 (G!; K!; ? MW; PRE, 2 sheets!; S!; W!; WU!; Z!).

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**Hanks & Small, N. Amer. Fl. 25: 23 (1907) also designated a lectotype species for the genus *Pelargonium*, but for reasons explained elsewhere (in press) this is not acceptable.

Geranospermum cardiophyllum (Harv.) Kuntze, Rev. Gen. 1: 94 (1891). *P. cardiophyllum* Harv. var. *laciniatum* Harv. l.c., syn. nov. Type: Cape, without precise locality, Zeyher s.n. (S!).

TYPIFICATION OF *PELARGONIUM MULTIFIDUM* HARV. AND *P. PLURISECTUM* SALTER

With the original description of *Pelargonium multifidum* Harv. in Fl. Cap. 1: 282 (1860) two specimens were cited, viz. Drège 9460 and Zeyher 2054 ('Herb. Sond.'). From this citation the impression is gained that two syntypes are involved. However, both numbers appear on single sheets in S, G and P, on two sheets in G and P respectively on the same label, whereas only the number Zeyher 2054 appears on sheets in P and W. The probable solution is provided by one of the three sheets in P, which bears both numbers as well as the inscription 'Legit Zeyher. Communicavit Drège ...'. It therefore seems as if only one collection is involved, namely Zeyher 2054 which was distributed under the number Drège 9460.

The material of this species in Harvey's collection (TCD) consists of three small branches of Zeyher 2054 and a tiny fragment marked Drège 9460, but without any indication of locality of origin so that it is unlikely that this sheet was used solely or mainly for compiling the original description. Sonder's main collection, referred to by Harvey, was acquired by Stockholm in 1875 and there is a sheet in S containing both numbers as well as the locality and name written on in Sonder's handwriting. We therefore designate this sheet as lectotype of *Pelargonium multifidum* Harv. (1860), non Salisb. (1796), as well as of *P. plurisectum* Salter (1941) which replaces the former name.

NEOTYPE FOR *PELARGONIUM DOLOMITICUM* KNUTH

With the original description of *P. dolomiticum* Knuth in Bot. Jb. 40: 71 (1907) it was stated that the type (Engler 2889) was housed in B ('Typus in herb. Berol.'). This specimen can no longer be traced in B, and it is presumed to have been destroyed during World War II. Neither could any duplicates be traced.

Although herbarium material of this species was borrowed from all the major herbaria in South Africa and Europe, it transpired that these collections do not contain any specimens with duplicates suitable for typification purposes. It appears as if the petals are easily shed during the preparation process, so that complete specimens with ample flowers proved to be very scarce. We finally decided to designate the following specimen as neotype: Orange Free State, (2926): Bloemfontein (–AA), J. W. Mostert 1661 (PRE!).

This is not a very neatly prepared specimen, but it has more flowers than most seen by us, and it is complete with mature fruits and part of the perennial basal part of the stem. It conforms with Knuth's original description, it is representative of the species and provides a good impression of the species in general.

Even though no type material survives, there is no doubt about the identity of *P. dolomiticum*. The original description did not mention that there are four petals only, but it did mention that the posterior petals are up to 20 mm long. This serves to distinguish *P. dolomiticum* from *P. senecioides* L'Hérit.

which has five petals not longer than ca. 9 mm, (with which *P. dolomiticum* is otherwise likely to be confused). In fact, even Knuth in Pflanzenr. 4, 129: 401–402 (1912) cited under *P. senecioides* a number of specimens which undoubtedly are *P. dolomiticum* [Dinter 976 (SAM!); 662; Fleck 488a; 571a; 821 (all in Z!)].

THE DELIMITATION AND TYPE COLLECTION OF *PELARGONIUM DASYPHYLLUM* E. MEY. EX KNUTH

The name *Pelargonium dasyphyllum* first appeared as a *nomen nudum* in Drège's Zwei pflanzengeographische Dokumente, pp. 60, 90, 91 and 209 (1843). Harvey, in Fl. Cap. 1: 279 (1860) listed it in the synonymy of *P. crithmifolium* J. E. Sm. Knuth, in Pflanzenr. 4, 129: 373 (1912) acknowledged it as a separate entity and validated the name by providing a description and indicating Drège 3245 as a type. In addition to the type, Knuth cited several other collections.

Of the material cited by Knuth, we have only been able to trace Rehmann 2776 and 2823 (both in Z) and two type sheets. The Rehmann specimens are very poor fragments impossible to identify positively, and were collected in the Hex River Valley, which is far outside the distribution area of *P. dasyphyllum* as indicated by other collections. Of the type sheets, the first, in P, consists of a fragment which appears to be the upper portion of a branch which branched rather profusely, with a dense mass of leaves and a single unbranched peduncle with a three-flowered pseudumbel. The second sheet, in PRE, consists of a single short, branched inflorescence branch, and came originally from P. It is not evident that it is a fragment of the specimen in P, so that it must be considered to be a duplicate. While these two fragments are hardly sufficient to provide an image of the species, Knuth's description could have been compiled from them, except for the fruit which is not evident on either of the sheets.

During our investigations of live material, both in the field and in cultivation, we separated a number of specimens of what we consider to be a separate species from *P. alternans* Wendl. These specimens seem to match the description and type of *P. dasyphyllum*.

According to our observations, *P. dasyphyllum* at first glance is morphologically very similar to *P. alternans* and only remotely resembles *P. crithmifolium*. It is, however, readily distinguishable from *P. alternans*, to such an extent that we have no hesitation in recognizing it as a separate species, as set out in Table 1. The branched inflorescence branches are nevertheless reminiscent of *P. crithmifolium*, and probably signify a close relationship to that species.

The length of the pedicel and the hairiness of the leaves are characters which usually hold good, but these cannot be used exclusively to distinguish the two species. *P. alternans* occasionally resembles *P. dasyphyllum* in respect of these characters and it is recommended that a combination of characters be used for this purpose.

The type locality of *P. dasyphyllum* was stated by Knuth (l.c.) to be 'near the Copper Mountains'. However, neither of the two sheets of the type collection which we have seen, bears that inscription. The sheet in P is labelled 'Camdeboosberg' on a label different from that bearing the number. This is probably wrong, as Camdeboosberg is far outside the

TABLE 1.—Comparison of diagnostic characters of *Pelargonium dasyphyllum* and *P. alternans*

Character \ Species	<i>P. dasyphyllum</i>	<i>P. alternans</i>
Leaves	Lamina setose, petiole microscopically setose	Both lamina and petiole conspicuously hirsute
Inflorescence	A thin, non-succulent, branched flowering stem, clearly differentiated from the succulent vegetative branches, with a few reduced leaves, flowering stem persistent for some time	A succulent, unbranched peduncle, not clearly differentiated from vegetative branches, not persistent.
Pedice	Conspicuous, $\frac{1}{2}$ –4× the length of the hypanthium	Inconspicuously short in relation to hypanthium
Petals	Reflexed at base	Reflexed in middle, especially 2 posterior ones
Geographical distribution	North-western Cape	Western and inland southern Cape

known geographical range of *P. dasyphyllum*. The sheet in PRE is labelled 'Zilverfontein', which is well within the known distribution range of this species. Drège (*op cit.*) cited three localities for *P. dasyphyllum*:

1. 'Camdeboosberg' (p. 60), which, as explained above, could not have been this species. The numbers cited also did not include the type number.
2. 'Zilverfontein' (p. 90) This is well within the known geographical range of this species, but again the cited numbers did not include the type number.
3. 'Zwischen Zilverfontein, Kooperbergen und Kaus' (p. 91). No collection numbers were cited, but the description of the locality is not dissimilar to that given by Knuth (*l.c.*). We therefore conclude that, despite the labels on the type sheets, the correct type locality is probably 'Between Zilverfontein, Copper Mountain and Kaus' (about $29\frac{1}{2}^{\circ}$ S, 18° E). We can only guess whether Knuth (*l.c.*) obtained his information from a now-lost sheet of Drège 3245 or deduced it from Drège (*op. cit.*).

Attention is drawn to a sheet in S which has the words 'Zwischen Zilverfontein, Kooperbergen and Kaus' typed on the label, and the name '*Pelargon. dasyphyllum*' written on in Meyer's handwriting. This may well be a duplicate of the type collection, but it lacks the number cited by Knuth. The specimen is a small fragment of poor quality.

ACKNOWLEDGEMENTS

We are indebted to the following instances and persons: the C.S.I.R. and the Research Fund of the University of Stellenbosch for financial support; Mr C. H. Stirton for determining for us the precise date of publication (7 September 1858) of the name *P. setulosum*, while stationed at Kew as liaison officer of the Botanical Research Institute; Mr P. Drijfhout, horticulturalist in charge of our live collection of *Pelargonium*, who collected information on the section *Otidia* of *Pelargonium* both in the field and in the greenhouse over several years, and who drew our attention to a number of characters separating *P. dasyphyllum* from *P. alternans*.

UITTREKSEL

Daar word op gewys dat die naam seksie *Pelargonium* DC. vervang moet word deur seksie *Pelargonium*, en *Pelargonium cardiophyllum* Harv. (1860) deur *P. setulosum* Turcz. (1858); *P. mossambicense* Engl. word gemeld as 'n nuwe rekord vir die Transvaal; 'n nuwe naam *P. ternifolium* Vorster word gegee aan *P. trifoliatum* Harv., *nom. illeg.*; en die tipifikasie van *P. multifidum* Harv., *P. plurisectum* Salter, *P. dolomiticum* Knuth en *P. dasyphyllum* E. Mey. ex Knuth word bespreek.

Notes on African plants

VARIOUS AUTHORS

AMARYLLIDACEAE

A NEW SPECIES OF *STRUMARIA*

Strumaria barbariae Oberm., sp. nov., *S. phonolithica* affinis, sed planta majora perianthio infundibuliforme differt.

Bulbus oblongo-ovoideus, c. 40 mm altus tunicis coriaceis in collo productis. *Folia* 2(–4), opposita, erecta, linearia, c. 120(–200) × 8 mm, apice breve acuto, *Umbella* pedunculo c. 400 mm longo; flores 6–12, patentes vel nutantes, pedicellis 15 mm longis. *Perianthium* infundibuliforme, c. 40 mm longum, album aliquantum roseolum. *Tepala* cohaerentia, lobis anguste obovatis, 10 mm longis. *Stamina* subaequalia, inclusa, fundo tepalorum vel styli connata; anthera alba, versatilis, dorsifixae. *Stylus* teretus, exsertus, 25 mm longus; stigmata 3, minuta; ovarium ovulis 6 in quoque loculo.

TYPE.—South West Africa, 2616 (Aus): farm 'De Aar', c. 30 km ESE of Aus (–CB), *Lavranos & Pehlemann 17153* (PRE, holo.).

Bulb oblong-ovoid, c. 40 mm tall, somewhat compressed laterally, the old leaf-bases forming a neck c. 50–90 mm long. *Leaves* subhysteranthous, 2–4 per shoot, erect, opposite, produced from a separate lateral bud, linear, up to 200 mm long when fully developed, 8 mm wide, shiny, dark green. *Umbel* c.

6(–12)-flowered; spathe valves 2, small, membranous; bracteoles small, filiform; pedicels 20–40 mm long, terete, firm. *Flowers* sweetly scented, patent to nutant, white but tinted light pink near base. *Tepals* 6, cohering to form a funnel-shaped tube c. 30 mm long and 7 mm in diam. above; lobes spreading, shortly acute. *Stamens* 6, subequal, the inner somewhat shorter; the filaments of the outer stamens fused to base of tepals, those of inner stamens fused to base of style forming a short triangular column; anthers yellow, versatile, introrse with parallel locules. *Ovary* 3-locular, ovules c. 6 in each locule; style terete, shorter than stamens, stigma obtuse, minutely 3-lobed. *Capsule* globose, c. 10 mm diam., thin-walled; seeds globose, c. 4 mm. Fig. 1.

S.W.A.—2616 (Aus): Farm De Aar, c. 30 km ESE of Aus, abundant but local on Schwarzkalk dolomite (–CB), *Lavranos & Pehlemann 17153*, *Erni 1038*, *Giess 13683*.

This species from the farm 'De Aar' in South West Africa was at first thought to represent Dinter's species *S. phonolithica*. Dinter's type was destroyed in Berlin in 1943 and his description is somewhat vague. However, bulbs collected by Merxmüller and Giess (28384) in the Klinghardt Mountains, Dinter's type locality, flowered in the Munich Botanic Garden in 1973–74 and disproved its identity with the De Aar species. Bulbs collected on farm De Aar in 1979 flowered at the Johannesburg Municipal Nurseries in February 1980. Mrs Barbara Jeppe painted them for a forthcoming book. It gave me this opportunity to dedicate the species to her in appreciation of the valuable contributions she has made to the knowledge of our flora.

Strumaria barbariae differs from *S. phonolithica* Dinter in its larger size and in the shape of the perianth, which is funnel-shaped, not salver-shaped as in the Dinter species. Both species lack the characteristic, often liver-coloured, ringed sheath surrounding the base of the leaf-cluster so often present in the Cape species. Most of these southern species form no perianth-tube or only a short one, the free tepals forming a loose bell-shaped perianth. In most of them the style-base is swollen (strumose), which suggested the name *Strumaria*. The genus is not well known.

A. A. OBERMEYER



FIG. 1.—*Strumaria barbariae*. Photo of holotype specimen, *Lavranos & Pehlemann 17153*, × 0.6.

ASCLEPIADACEAE

THE *RIOCREUXIA FLANAGANII* COMPLEX: A REASSESSMENT

The *Riocreuxia flanaganii* complex [see R. A. Dyer in *Bothalia* 12,4: 632 (1979) and in *Fl. S. Afr.* 27,4: 87 (1980)] is reassessed in this note. Of the three subspecies, subsp. *woodii* is restored to specific rank, subsp. *alexandrina* is raised to specific rank and subsp. *segregata* is reduced to synonymy under *R.*

burchellii.

The revised relationship of the four previous subspecies is reflected in the following key. In all taxa the outer corona arises from above the base of the staminal column and the inner lobes reach as high as or higher than the staminal column.

Outer corona-lobes small, not spreading, 2-toothed; peduncles 0–20 mm long; corolla 10–12(13) mm long; stems bifariously pubescent 1. *R. flanaganii*
 Outer corona-lobes spreading or spreading-erect; peduncles usually 20 mm or more long; stems usually unifariously pubescent:
 Outer corona-lobes slender, spreading-erect, bifid, equal to or overtopping staminal column; corolla 8–10(12) mm long 2. *R. alexandrina*
 Outer corona-lobes spreading, subtruncate of bifid; corolla (14)15–18 mm long:
 Inflorescence of (1)2 umbellate clusters of flowers; corolla \pm 15 mm long; tube with globose base; outer corona-lobes \pm truncate 3. *R. woodii*
 Inflorescence usually elongate, several-noded, rarely only (5) 20 mm long, few to several flowers from a node; corolla \pm 17 mm long with slightly inflated base; outer corona lobes spreading, bifid 4. *R. burchellii*

1. ***Riocreuxia flanaganii* Schltr.** in Bot. Jb. 18, Beibl. 45: 13 (1894); R.A. Dyer in Fl. S. Afr. 27,4: 87 (1980) in part excluding subspp. *woodii*, *segregata* and *alexandrina*.

It is recommended that the concept of this taxon should revert to that afforded it by the original author, Schlechter, and substantiated by N. E. Br. in Fl. Cap. 4,1: 804 (1908), with a distribution in the eastern Cape and southern Transkei.

2. ***Riocreuxia alexandrina* (Huber) R.A. Dyer**, stat. nov.

Ceropegia flanaganii Schltr. var. *alexandrina* Huber in Mems Soc. broteriana 12: 169 (1958). *Riocreuxia flanaganii* Schltr. subsp. *alexandrina* (Huber) R. A. Dyer in Bothalia 12: 632 (1979); in Fl. S. Afr. 27, 4: 88 (1980).

Perennial herb with a cluster of subfleshy roots. *Stems* twining, with scattered hairs or hairs in single row. *Leaves* broadly cordate at base, ovate-lanceolate, up to about 75 mm long, 50 mm broad, more or less hairy. *Peduncles* short or up to about 35 mm long, with rather dense, more or less terminal clusters of flowers. *Corolla* 8–10(12) mm long, $\frac{1}{2}$ – $\frac{2}{3}$ divided; tube slightly inflated near base, 3–5 mm long; lobes 5–6 mm long, filiform, united at tips. *Staminal column* about 1 mm high. *Corona* arising about halfway up staminal column; outer lobes slender, spreading-erect, as high as or slightly higher than

staminal column; inner lobes oblong-erect, membranous, slightly higher than the staminal column.

Our knowledge of this species is based on specimens collected by *Rudatis* 1540 in southern Natal, inland from Port Shepstone, near Moyeni at about 700 m. Some specimens are associated with tall grassland. The species is notable for its small flowers, the corolla of which is divided to at least half to two-thirds of its length.

3. ***Riocreuxia woodii* N. E. Br.** in Fl. Cap. 4,1: 803 (1908).

Riocreuxia flanaganii Schltr. subsp. *woodii* (N. E. Br.) R. A. Dyer in Bothalia 12,4: 632 (1979); in Fl. S. Afr. 27,4: 87 (1980).

Ceropegia flanaganii Schltr. var. *fallax* Huber in Mems Soc. broteriana 12: 169 (1958).

This species is known only from the type specimen collected over 100 years ago by Medley Wood, near Inanda, inland from Durban. The locality falls within the distribution area of the variable species *Riocreuxia torulosa* Decne. and it requires careful observation of the coronal structure to distinguish the two species. Its association with *R. flanaganii* seems unwarranted and its resuscitation to specific rank is advocated.

4. ***Riocreuxia burchellii* K. Schum.** in Natürl. Pflfam. 4,2: 273 (1895); R. A. Dyer in Fl. S. Afr. 27,4: 85 (1980).

Riocreuxia flanaganii Schltr. subsp. *segregata* R. A. Dyer in Bothalia 12,4: 632 (1979); in Fl. S. Afr. 27,4: 87 (1980).

Of the two known collections placed under *R. flanaganii* Schltr. subsp. *segregata*, the one, *Fitz-Simons & Van Dam* in TRV 25981 (PRE), was originally identified as *R. torulosa* Decne. and the other, *Pole Evans* 19656 was originally identified as *R. picta* Schltr. The abnormally short peduncles of these two cited specimens distracted attention from the third species with an overlapping distribution near Wakkerstroom, namely *R. burchellii* (= *R. polyantha*). The reassessment is that the two specimens in question represent an unusual growth form of *R. burchellii*.

R. A. DYER

COMMELINACEAE

TWO NEW SPECIES OF COMMELINA

***Commelina bella* Oberm., sp. nov.** *C. livingstonii* affinis, sed planta majora, robustiora, foliis ad marginem crenulatis, albis, racemo inferiore, 1–3-floribus, longe pedunculato valde differt.

Herba perennis (chamaephyta), erecta, compacta, setulosa, ad 350 mm alta. *Caudex* compactus, radicibus lignosis longis. *Folia* linearia 40–50 \times 10 mm, margine undulato incrassato albo. *Spathae* 1–2, ad apicem ramorum sessiles. *Cymae* 2; inferiora 1–2-flora; stipes c. 25 mm longus, setulosus; cyma superiora c. 3–4-flora. *Flores* grandes, pallide caerulei, lilacini vel albi. *Petala* c. 20 mm. *Stamina* typica; anthera caerulea; staminodia antherodis bulbosis flavidis. *Capsula* oblongo-globosa, dura.

TYPE.—Transvaal, 2428, (Nylstroom): 20 km S of Warmbaths on Great North Road (–CD), along roadside, *Snook 1494* (PRE, holo.).

Sturdy compact bushes (chamaephytes) c. 0,35 m tall, setulose with short white setae; with a hard gnarled rootcrown and long firm woody roots. *Stems* erect, firm, with internodes c. 50 mm long. *Leaves* linear, c. 40–50 \times 10 mm, apex sharply acuminate-

recurved, base merging into a short open sheath, light greyish-green, margin undulate, forming a thick white rim. *Spathes* terminal, opposite upper leaves, sessile, funnel-form, triangular, apex acute to acuminate, recurved, c. 25 mm long. *Cymes* 2; lower cyme much exserted on a hairy peduncle c. 25 mm long, 1–2-flowered, male; upper cyme c. 3–4-flowered, bisexual. *Flowers* pale blue, lilac or white, large. *Petals* c. 20 mm. *Stamens* 3, two with normal blue locules, the central curled with a large connective; filaments white; staminodes with purple filaments and orange-yellow antherodes consisting of 4 bulbous bodies and 2 smaller ones. *Capsule* oblong-globose, hard, c. 10 mm, 3-seeded; seeds smooth. (No well developed capsule seen.) Fig. 2.

Recorded from the Springbok Flats in the Transvaal in turf soil. Flowering November–January.

TRANSVAAL.—2428 (Nylstroom): 20 km S of Warmbaths on Great North Road (–CB), *Snook 1494*; Warmbaths (–CD), *Burt Davy* 2232; Singlewood Halt (–DB), *Mauve* 4279. 2527 (Rustenburg); near Brits (–DB), *Ennmenis* in PRE 38063. 2528 (Pretoria): Rust de Winter (–BA), *Pole Evans* 3852.



FIG. 2.—*Commelina bella*. Smook 1494, holotype in PRE.

***Commelina modesta* Oberm., sp. nov.** *C. livingstonii* affinis, sed planta minora, laxa, glabra vel glabrescens; spathis floriferis solitariis ad apicem ramorum; laminae folii basin versus sensim in vaginam attenuata differt.

Herba perennis (chamaephyta), erecta, laxa ramosa. Caulex compactus, radicibus longis lignosis. Rami tenues, internodiis elongatis. Folia linearia, c. 80(–100) × 4 (–10) mm, plana, glabra vel pauce glabriuscula, lamina basin versus sensim in vaginam

attenuata. *Spatha* singularia, ad apicem ramorum, sessilis, infundibuliformis, triangularis, apice acuta. *Cyma* solitaria. *Flores* parvi, albi vel caerulei. *Cap-sula* 3–locularis; loculi globosi, laevigati; semina globosa, laevigata.

TYPE.—Transvaal, 2531 (Komatipoort): Barberton, lower hill slopes (–CC), *Galpin* 808 (PRE, holo.).

Small spreading, diffusely branched, glabrescent bushes (chamaephytes) up to c. 0.3 m tall. *Rootstock* woody, gnarled, knobby (the knobs presenting remains of swollen bases of annual stems); roots woody, long, initially covered by a velamen of root-hairs. *Stems* several, erect, with long internodes up to 60–100 mm long. 1–2 mm in diam. *Leaves* with lamina linear, flat, 80–100 × 4–10 mm, attenuated at the base into a pseudo-petiole, white-punctulate; sheath membranous, subauriculate. *Flowering spathe* solitary (rarely 2), apical, sessile or nearly so, funnel-form, shortly triangular, 15 mm long, 10 mm broad, apex short, acute, minutely puberulous and with scattered white setae. *Cyme* solitary. *Flowers* small, blue or white ("pink" fide *Galpin* 808). *Sepals* ovate, c. 5 mm, membranous, upper minute. *Petals*: upper one rounded, c. 15 mm ventral ones minute. *Stamens* typical, the anthers occasionally with dark margins, the central semicircular; staminodes with yellow bulbous antherodes. *Capsule* with globose, shiny, cream-coloured locules; seeds globose, 5 mm, smooth, farinaceous, dorsal seed occasionally aborted.

Widespread in Transvaal, Natal and Swaziland, in rocky habitats. Flowering November–March.

TRANSVAAL.—2230 (Messina): Sand River workings (–AC), *Wild* 7624 (SRGH, PRE). 2330 Tzaneen: Mbayimbayi (–BB), *Lang* in TRV 32230 (PRE). 2428 (Nylstroom): Nylsvley Ecosystem Research Station (–DA), *Smook* 1491, 2527 (Rustenburg): Rustenburg (–CA), *Van Dam* in TRV 19714 (PRE). 2528 (Pretoria): Pretoria, Schanskop (–CA), *Leemann* 51 (PRE). 2530 (Lydenburg): Lowveld Botanic Garden, Nelspruit (–BD), *Buitendag* 371 (NBG, PRE).

NATAL.—2632 (Bella Vista): Nkonjane-Aberkorn Drift (–CC), *Moll & Pooley* 4197 (NH). 2731 (Louwsburg): Itala Nature Reserve (–CB), *McDonald* 332 (PRE, NH). 2732 (Ubonbo): mountain pass near Josini Dam, *Stirton* 498 (PRE). 3030 (Port Shepstone): Gibraltar (–CB), *Strey* 10343 (PRE, NH).

This species was previously placed under *C. livingstonii* C. B. Cl., but is a more slender bush found in rocky habitats. The leaves narrow gradually below into a pseudo-petiole, whereas in *C. livingstonii* they widen below and then narrow abruptly into the sheath.

A. A. OBERMEYER

A NEW COMBINATION IN *COMMELINA*

***Commelina diffusa* Burm. f. subsp. *scandens* (C.B. Cl.) Oberm., comb. et stat. nov.**

Commelina scandens Welw. ex C. B. Cl. in A. DC., Monogr. Phan. 3: 146 (1881); F.T.A. 8: 37 (1901). Type: Angola, Pungo Andongo, banks of River Cuanza near Nbillia, *Welwitsch* 6642 (BM, holo.).

This subspecies is common along watercourses in northern Botswana and it also occurs in the warmer parts of the Transvaal and Natal in wet habitats. It is more robust than the typical variety and has longer leaves.

A. A. OBERMEYER

TWO NEW SPECIES OF *CYANOTIS*

***Cyanotis pachyrrhiza* Oberm., sp. nov., species distincta.**

Herba colonifera, repens, diffusa. *Caudex* compactus, radicibus numerosis longis, robustis, crassis. *Folia* 5–7, aggregata, linearia, c. 70–150 × 5–8 mm,

supra glabra nitida, subtus violacea, pilis erectis albis. *Spicae* axillares, saepe pedunculatae, multiflorae, compactae. *Spathae* cordatae, saepe elongatae, spicas longe superantes. *Bracteolae* parvae. *Flores* et fructus typici.

TYPE.—Transvaal, 2430 (Pilgrims Rest); Ohrigstad Dam, on rocky hill slopes (—DC), *Mauve & Retief* 5245 (PRE, holo.).

Perennials forming colonies, with a purple colouring and soft white pubescence. *Caudex* compact, small. *Roots* many, long, hard, tapered below, thick, c. 3 mm in diam., white (black when dry). *Leaf-cluster* with 5–7 erect, linear leaves. c. 70–150 × 5–8 mm, glabrous and shiny above, purple below and with erect white hairs. *Spikes* axillary, on erect or semi-decumbent annual stems; flowers many in a compact cluster, often pedunculate, the subtending spathe long and narrow, recurved, not enveloping flowers, or in some short; bracteoles small, ovate. *Calyx* with lobes fused basally, c. 7 mm, setose. *Corolla* just exerted from calyx, maroon; lobes triangular. *Stamens* with white filaments, fusiform below apex where the maroon, beaded, patent hairs are situated; anthers yellow. *Style* fusiform below stigma. *Capsule* subquadrate, sparsely setose above; seeds oblong-globose, c. 1.5 mm, wrinkled. Fig. 3.

So far only recorded from the eastern Transvaal, but with one record from the north-western Transvaal, montane, on rock ledges (quartzite). Flowering December.

TRANSVAAL.—2428 (Nylstroom): Geelhoutkop (—AD), *Breyer in TRV 17813*. 2430 (Pilgrims Rest): Mariepskop (—DB), *Van Dam in TRV 26303*; Lissabon Waterfall (—DD), *De Feyter 65*. 2530 (Lydenburg); top of Steenkampsberg (—AA), *Codd 8052* (PRE); Dullstroom (—AA), *Galpin 13126*; Mount Anderson (—BA), *Smuts & Gillett 2434*.

Cyanotis robusta Oberm., sp. nov., *C. lapidosa* Phill. affinis, sed planta majora, robustiora, radicibus crassibus lignosis, lobis calycis c. 10 mm longis differt.

Herba colonifera, robusta. *Radices* crassae, longae, lignosae. *Folia* inequalia, 5–7, rosulata, linearia, 100(–300) × 15–20 mm, supra glabra, subtus lanata, pilis albis longissimis tenuis appressis. *Spicae* axillares, multiflorae, compactae. *Calycis lobi* lineari, c. 10 mm longi. *Flores* coerulei vel lilacini, typici.

TYPE.—Natal, 2830 (Dundee): along road between Mooi River and Weenen, c. 10 km past Middelrus (—CC), on rock ledges, under bushes, *Arnold 1372* (PRE, holo.).

Spreading rhizomatous perennials forming colonies, saxicolous. *Roots* many, long, c. 4 mm thick (outer tissues apparently somewhat spongy). *Rhizome* compact, small, covered by lanate remains of leaf-bases. *Leaves* spreading, unequal in size, linear, 80(–300) × 15–20 mm, smooth and shiny above, lanate below with long thin white appressed hairs. *Flowering stems* annual, basal, spreading, c. 200–300 mm long; cymes axillary, compact, enveloped by long canaliculate spathes, c. 20–50 mm, becoming progressively smaller towards apex. *Flowers* c. 5–10 in each axil, pale sky-blue to mauve. *Calyx* with linear lobes c. 10 mm long, glabrescent to lanate. Stamens etc. typical of genus. Fig. 4.



FIG. 3.—*Cyanotis pachyrrhiza*. a whole plant, × 0.5; b, flower with bract and bracteoles, × 1.5; c, stamen, × 3.5; gynoecium, × 3.5. *Mauve & Retief* 5245.



FIG. 4.—*Cyanotis robusta*. Arnold 1372, holotype in PRE.

TRANSVAAL.—2430 (Pilgrims Rest): Wolkberg, NW face of Seralia Peak (—AA), Müller & Scheepers 165 (PRE).

NATAL.—2830 (Dundee): Umkhumba Mountain near Weenen (—CC), West 1441 (NH); between Mooi River and Weenen (—CC), Arnold 1372, 2929 (Underberg); Joneskloof near Estcourt (—BB), West 1538 (NH).



FIG. 5.—*Ficinia* × *lucida* C. B. Cl., Bolus 6082 (K, holotype), an interspecific hybrid between *Ficinia cedarbergensis* and *F. ixiooides* subsp. *glabra*.

The long thick roots and more robust habit distinguish it from *C. lapidosa*. There appears to be variation in size and degree of pubescence.

A. A. OBERMEYER

CYPERACEAE

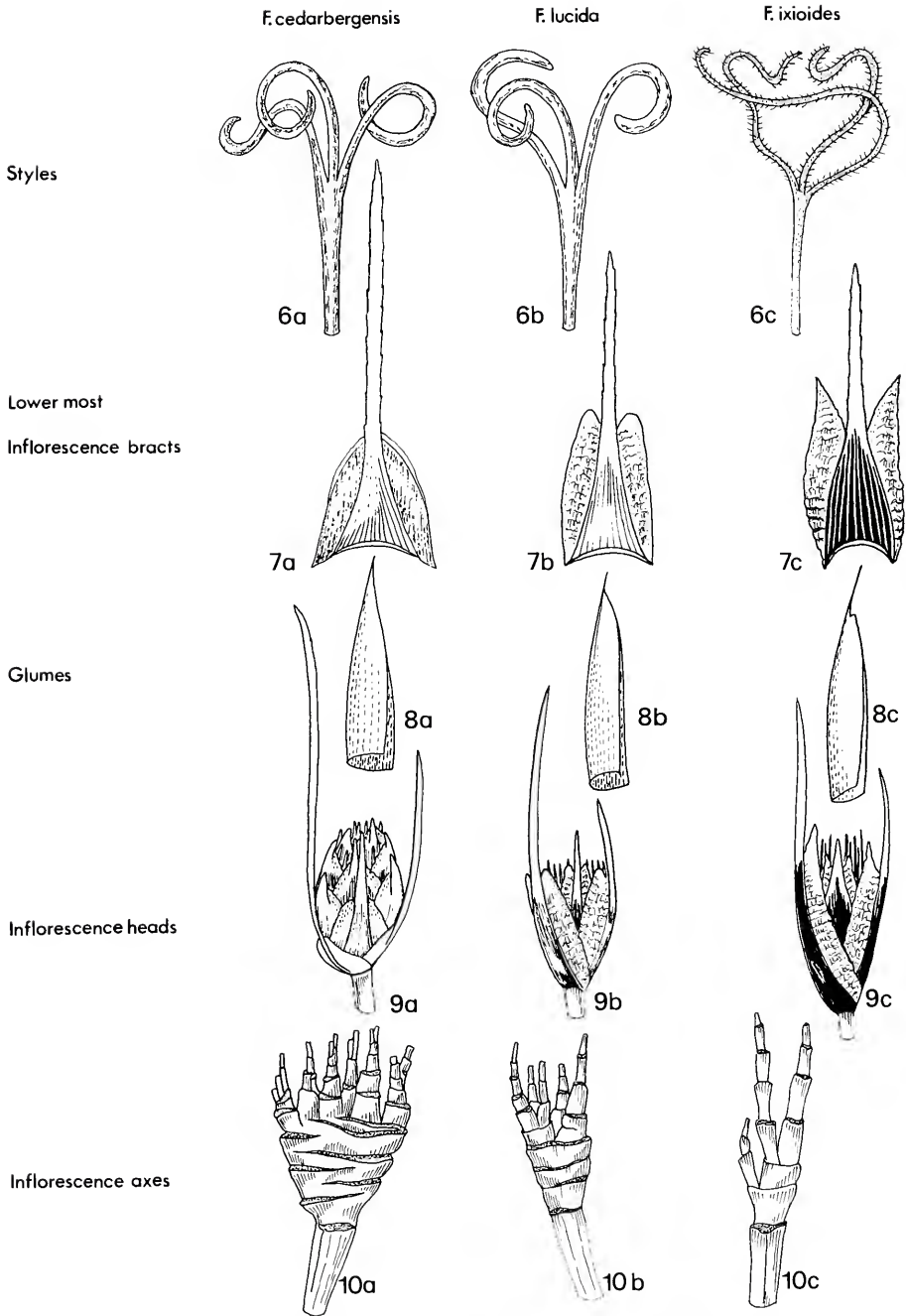
FICINIA LUCIDA: AN INTERSPECIFIC HYBRID BETWEEN *F. CEDARBERGENSIS* AND *F. IXIOIDES* SUBSP. *GLABRA*

The type of *F. lucida* C. B. Cl. (Bolus 6023, Fig. 5) was collected in the Cedarberg mountains of the western Cape Province in 1878, a little over one hundred years ago. It most closely resembles *F. cedarbergensis* Arnold & Gordon-Gray and *F. ixiooides* Nees subsp. *glabra* Arnold & Gordon-Gray, possessing characters of both these taxa, yet it cannot satisfactorily be placed in either of them.

F. lucida resembles *F. cedarbergensis* mainly in vegetative form, and in the form of the style and inflorescence axis. Its inflorescence bracts and glumes and the overall form of the inflorescence are more like those of *F. ixiooides*. In *F. lucida*: (i) the style is thick, red and granular (Fig. 6b) like that of *F. cedarbergensis* (Fig. 6a) and unlike that exhibited by *F. ixiooides*, which is long, slender, light brown and papillate (Fig. 6c); (ii) the 2 or 3 outermost inflorescence bracts have papery lobes along their margins, a condition not found elsewhere in *Ficinia*, except in *F. ixiooides*, and unlike that in *F.*

cedarbergensis (see Figs 7a–c); (iii) the glumes have obtuse, apiculate apices — a feature absent in *F. cedarbergensis*, yet closely resembling the situation found in *F. ixiooides* (see Figs 8a–c); (iv) the sheathing bases of the lower 2–3 inflorescence bracts enclose the head more or less completely, as in *F. ixiooides*, and unlike *F. cedarbergensis* in which only 1/3 of the head is covered (see Figs 9a–c); and (v) the inflorescence axes, although somewhat intermediate in form, are more typical of the type characterizing *F. cedarbergensis* (see Figs 10a–c).

Two of the characters that *F. lucida* shares with its putative parents, are rare in the genus *Ficinia*. The species (mentioned below), which do share these features, all have distributions disjunct from *F. lucida* and its putative parents: (i) the only other species to possess a red, granular style is *F. levynsiae* Arnold & Gordon-Gray; (ii) the only other species to possess the same form of inflorescence axis is *F. petrophylla* Arnold & Gordon-Gray.



FIGS 6 – 10.—Comparative morphology of styles ($\times 8$), inflorescence bracts ($\times 2$), glumes ($\times 6,5$), inflorescence heads ($\times 2$), inflorescence axes ($\times 4$) between *Ficinia cedarbergensis*, *F. ixioides* subsp. *glabra* and *F. lucida*.

It is here postulated that *F. lucida* C. B. Cl., known only from a single specimen (*Bolus* 6023, Fig. 5), is of hybrid origin. This theory cannot be proved at present, since no breeding, chromosome or pollination studies have been carried out in the genus. The evidence for a hybrid origin of *F. lucida* rests on its intermediacy between two distinct species that are very different morphologically; the lack of other specimens that even remotely resemble it; the likelihood of cross-pollination (outbreeding) in the group, as indicated by protandry and probable wind pollination; and the occurrence of the putative parent species in the type locality (see Fig. 11).

The idea of interspecific hybridization within *Ficinia* is not new. Levyns (1950) in her treatment of the genus for the Flora of the Cape Peninsula stated that hybrids between certain species appeared to exist. Hybridization is certainly suspected to be responsible for much of the variation within the section *Bracteosae* of *Ficinia*. It appears not only to have brought about the blurring of specific boundaries in the *F. indica*-complex but has possibly been an important factor in the origin of some species such as *F. grandiflora* Arnold & Gordon-Gray.

The status of *F. lucida* C.B.Cl. is therefore altered as follows:

***Ficinia* × *lucida* C. B. Cl.** in Dur. & Schinz, Consp. Fl. Afr. 5: 640 (1895). Type: South Africa, Cape, Cedarberg mountains, Clanwilliam Div., *Bolus* 6023 (k, holo!).

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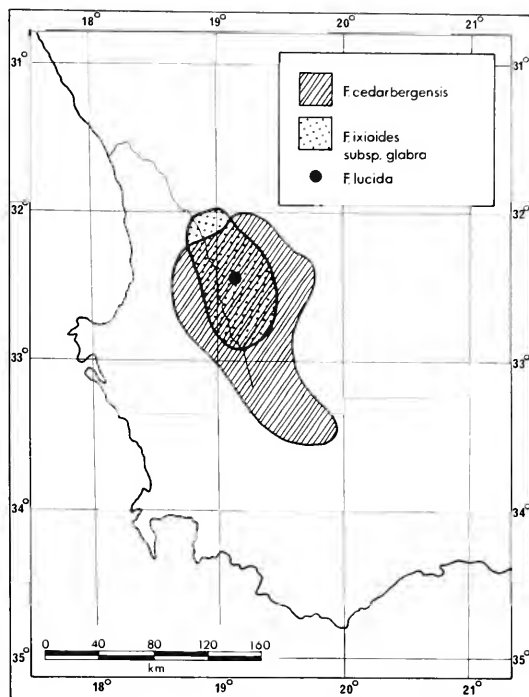


FIG. 11.—Sympatric distribution of *Ficinia cedarbergensis*, *F. ixioides* subsp. *glabra* and *F. lucida*.

ECOLOGICAL ADAPTATIONS AND POSSIBLE CONVERGENCE IN *FICINIA ARENICOLA* VAR. *ERECTA* AND *MARISCUS DURUS*

An obvious, although superficial similarity exists between two fairly remotely related members of the family Cyperaceae, namely *Ficinia arenicola* Arnold & Gordon-Gray var. *erecta* Arnold & Gordon-Gray and *Mariscus durus* (Kunth) C. B. Cl. Morphological, anatomical and ecological comparison has revealed additional shared characters which may be interpreted as an example of convergence in these two taxa.

The geographical distributions of these taxa (Fig. 12. 1a & 2a) are almost identical: extending along the southern Cape coast from Mossel Bay to just east of Port Elizabeth (22°E–27°E) i.e. in an intermediate zone between the summer and winter rainfall regions. Both taxa are normally restricted to a 5–10 km wide belt of grassland, close to the sea, but extend slightly further inland (up to 30 km) between 26°E and 27°E.

In *M. durus* the inflorescence takes the form of a simple, more or less contracted umbel (Fig. 12. 1b) and in *F. arenicola* var. *erecta* (Fig. 12. 2b) it is a compact head-like spike. In both taxa the inflorescence is terminally situated at the apex of the inflorescence stem, but appears to be lateral or sub-lateral due to the presence of the lowermost inflorescence bract which closely resembles and outwardly appears to be a continuation of the culm (particularly in *M. durus*). This condition is rare in both genera.

The resemblance in habit (Fig. 12. 1b & 2b) between these taxa is enhanced by the similarity in plant size. The culms of *M. durus* average 260 mm in height, whereas in *F. arenicola* var. *erecta* the average height is 240 mm.

In both taxa the stem bases are woody and are covered by old persistent leaf bases. In *M. durus* they

are horizontally or obliquely displaced and are notably thickened, whereas in *F. arenicola* var. *erecta* they are erect and slender. Both taxa have slender horizontal, wiry subterranean stolons, 2 or 3 mm in diameter. These extend to a length of 2–12 cm and are clothed in light brown lanceolate, papery scales. Each stolon originates laterally from the base of the stem and forms a single new plant at its extremity.

The leaves of both taxa generally exceed the culms in height. They are olive-green in colour, glabrous, erect and rigid, lack a midrib, are subcylindrical to reniform in cross section (sometimes with the apex dorsiventrally flattened) and superficially closely resemble the culms. In *Ficinia* this leaf type is not uncommon, also being found in *F. ixioides* Nees subsp. *glabra* Arnold & Gordon-Gray, *F. pinquior* C. B. Cl. and *F. deusta* (Berg.) Levyns. Among the South African species of *Mariscus*, however, *M. durus* is the only species without expanded leaf blades. This leaf shape, resulting from the permanent infolding of the leaf margins, is usually regarded as a direct adaptation to water stress, with the degree of infolding of the leaf margins having been correlated with dry environmental conditions as it effectively reduces the leaf area from which transpiration can take place (Metcalf, 1970).

The taxa grow in almost identical habitats and have on occasion been seen to grow side by side. They are confined almost exclusively to the margins of seasonally inundated depressions. The soil of these depressions is usually a heavy, dark clay which binds residual water and reduces its availability during dry periods (Russell, 1950; Hillel, 1971). Protective adaptation against desiccation may also be necessary as these plants often grow close to the sea where the soil and air have a high saline content. According to Dyer

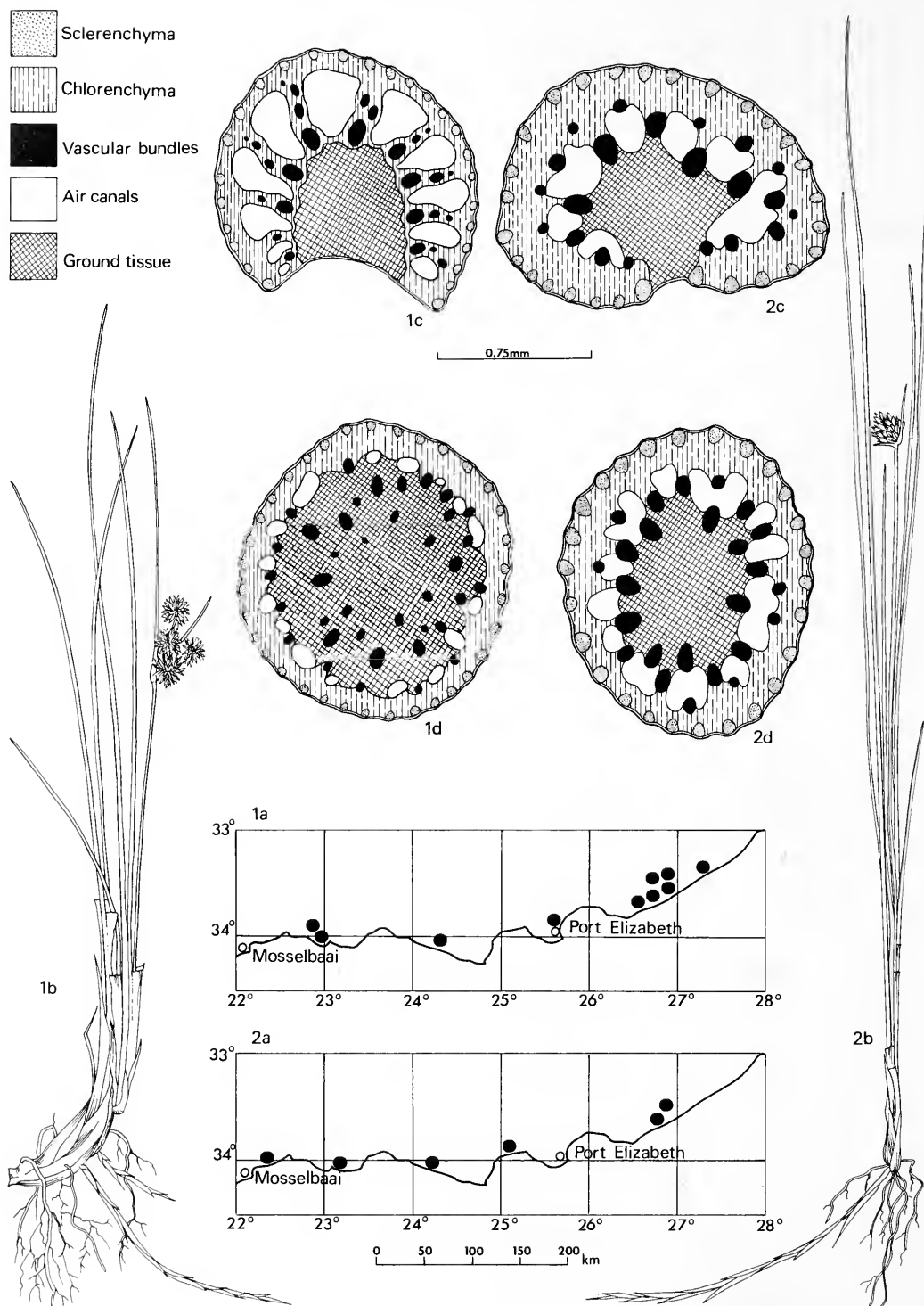


FIG. 12.—Comparison of distribution, morphology and leaf and culm anatomy. 1a–d, *Mariscus durus*; 2a–d, *Ficinia arenicola* var. *erecta*. 1a & 2a, sympatric distribution. 1b & 2b, habit (1b, Vorster 2332, $\times 0.25$; 2b, Arnold 603, $\times 0.5$) illustrating erect growth form with leaves over-topping the inflorescence and well-developed subterranean stolons. 1c & 2c, transverse sections of leaf blade (1c, Vorster 2358; 2c, Arnold 603) showing large air canals, reduced abaxial surface and similar tectate outline. 1d & 2d, transverse sections of culm (1d, Vorster 2342; 2d, Arnold 603) showing circular distribution of air canals.

(1937) salt vleis and saline marshes near the coast, without direct communication with the sea, are characterized by a rich cyperaceous flora, including *M. durus*.

A study of the cross-sectional leaf anatomy of these taxa (Fig. 12. 1c & 2c) shows that both have well-developed chlorenchymatous tissue limited to a band directly adjacent to the abaxial epidermis. The vascular bundles in both taxa are typically collateral, extending in an arc through the centre of the leaf between the chlorenchyma and ground tissue (hypodermis), and decreasing in size towards the infolded, somewhat obscure, leaf margins.

An arc of large, well-developed lacunae or air canals is a typical feature of the anatomy of both taxa. In *M. durus* these are surrounded by chlorenchyma and are located between radial rows of 1–4 vascular bundles which increase progressively in size towards the ground tissue. In *F. arenicola* var. *erecta* the air canals are irregularly dispersed between the vascular bundles without a regular pattern of arrangement.

In cross-section the culms of *M. durus* (Fig. 12. 1d) are circular, and in *F. arenicola* var. *erecta* (Fig. 12.2d) they are slightly elliptical in shape. In both taxa a band of chlorenchyma occurs immediately adjacent to the epidermis. In *M. durus* the air canals are smaller and more regular in shape and are located in a circle along the margin between the chlorenchyma and ground tissue alternating with the outer vascular bundles. In *F. arenicola* var. *erecta* the irregularly shaped air canals are located between the smaller outer vascular bundles and the larger inner bundles and ground tissue perimeter.

The presence of large well-developed air canals in the leaves and culms of these taxa is seen as a significant and necessary adaptation to water-logging of the soil and periodic partial submergence of the plants during the wet season. The air canals are essential for

aeration of the subterranean parts of the plant during flooding (Sifton, 1957; Esau, 1965; Fahn, 1969). In contrast, in *F. arenicola* var. *arenicola* which grows in well-drained, well-aerated sandy soil (often in close proximity to var. *erecta*), the air canals if present at all, are poorly developed and very small, being less than $\frac{1}{4}$ the size of the largest vascular bundles. A detailed account of the anatomical differences exhibited by the two varieties of *F. arenicola* will be presented in a later paper. *M. durus* lacks air canals in the leafy extensions to the culms, representing the lowermost inflorescence bract, notwithstanding the presence of well-developed canals in the culms. No information on this aspect is available for *F. arenicola* var. *erecta*.

The morphological and anatomical similarities exhibited by these two taxa could be interpreted as a possible example of convergent evolution resulting from their apparent adaptation of the same ecological niche, where they cope with extremes in water availability at various times of the year. On the one hand the need exists for water conservation during dry periods, while conversely, good aeration becomes critical during excessively wet periods.

REFERENCES

- DYER, R.A., 1937. The vegetation of the divisions Albany and Bathurst. *Mem. bot. Surv. S. Afr.* 17: 60.
 ESAU, K., 1965. *Plant anatomy*. 767 pp., New York: John Wiley.
 FAHN, A., 1969. *Plant anatomy*. 534 pp., London: Pergamon Press.
 HILLEL, D., 1971. *Soil and water, physical principles and processes*. 288 pp., London: Academic Press.
 METCALFE, C. R., 1971. *Anatomy of the monocotyledons. 5, Cyperaceae*. 597 pp., London: Oxford University Press.
 RUSSELL, E. W., 1950. *Soil conditions and plant growth*. 635 pp., London: Longmans, Green.
 SIFTON, H. B., 1957. Air-space tissue in plants. *Bot. Rev.* 23: 300–312.

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THE CORRECT AUTHOR CITATION FOR *MARISCUS MACROPUS*

The combination *Mariscus macropus* is usually attributed to C. B. Clarke with Böckeler as author of the basionym *Cyperus macropus* Böck. (1870). But *Cyperus macropus* (Böck.) is illegitimate, being a later homonym of *C. macropus* Miq. (1860). However, if, following Article 72 of ICBN (1978), the epithet

macropus on transfer to *Mariscus* is treated as new, dating from 1895, the resulting combination is treated as new, and is attributed solely to C. B. Clarke, thus: *Mariscus macropus* C. B. Clarke.

P. J. VORSTER

THE CORRECT AUTHOR CITATION FOR *MARISCUS DUBIUS*

Most recent authors, e.g. Kükenthal in *Pflanzenr.* 101, 4, 20: 563 (1936); Podlech in *Mitt. bot. Stsamm.*, Münch. 3: 524 (1960); in *Prodr. Fl. S. W. Afr.* 165: 37 (1967); Napper in *Jl E. Africa nat. Hist. Soc.* 28: 17 (1971); Gordon-Gray in *Ross, Flora of Natal* 106 (1972) attribute the combination *Mariscus dubius* to Hutchinson in *Fl. W. Trop. Afr.* ed. 1, 2: 485 (1936) with Rottb. as author of the basionym. Hutchinson's combination is, however, antedated by that which appeared in Gamble, *Fl. Madras* 1644

(1931). In *Fl. Madras* the treatment of the Cyperaceae is attributed to G. E. C. Fischer, but in the text the combination *M. dubius* is ascribed to Kükenthal. Five years later in *Pflanzenr.* 1.c., Kükenthal attributed the combination to Hutchinson, presumably unaware of Fischer's earlier action. Following Rec. 46C of the ICBN (1978) the combination should be written thus: *M. dubius* (Rottb.) Kükenth. ex G. E. C. Fischer.

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ON THE IDENTITY AND GEOGRAPHICAL DISTRIBUTION OF *MARISCUS ANGULARIS*, *M. CHERSINUS*, *CYPERUS BULLATUS* AND *C. CAPENSIS* VAR. *POLYANTHEMUS*

In the course of a revision of the taxonomy of the South African species of *Mariscus*, the following type specimens were examined and found to represent one and the same species:

1. *Lugard* 142 (GRA!); *Harbor sub Rogers* 6310 (BOL!; J!); syntypes of *Mariscus chersinus* N. E. Br. in *Kew Bull.* 1921: 300 (1921).

2. *Dinter* 2354 (B!): type of *Cyperus bullatus* Kükenth. in *Reprim nov. Spec. Regni veg.* 29: 198 (1931).

3. *Schlechter* 11683 (B!; G!; Z!): type of *Cyperus capensis* (Steud.) Endl. var. *polyanthemus* Kükenth. in *Pflanzenr.* 101, 4, 20: 540 (1936).

The earliest name is *Mariscus chersinus* N. E. Br (1921) and therefore it is the correct name to use for this taxon. The synonymy is as follows:

***Mariscus chersinus* N. E. Br.**

Cyperus bullatus Kükenth. in *Reprim nov. Spec. Regni veg.* 29: 198 (1931).

C. chersinus (N. E. Br.) Kükenth. in *Pflanzenr.* l.c. p. 525 (1936).

C. capensis (Steud.) Endl. var. *polyanthemus* Kükenth. l.c. p. 540.

Mariscus bullatus (Kükenth.) Podlech in *Mitt. bot. Stsaml., Münch.* 3: 523 (1960).

It is surprising that Kükenth maintained *C. chersinus*, *C. bullatus* and *C. capensis* var. *polyanthemus* as three distinct taxa. His recognition of spurious dif-

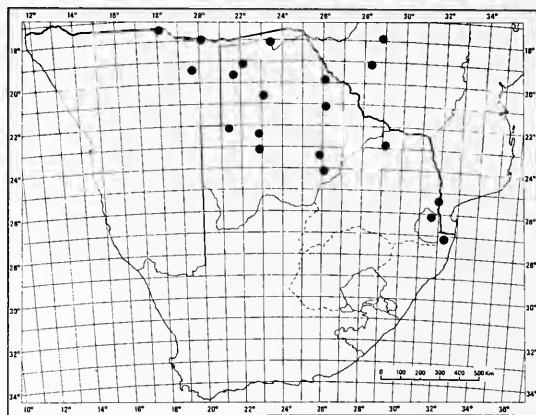


FIG. 14.—*Mariscus chersinus*. Known geographical distribution.

ferences was clearly influenced by the apparently disjunct geographical distribution of these taxa. Kükenth placed *M. chersinus* (as *Cyperus chersinus*) in *Cyperus* sect. *Umbellati*, whereas *C. bullatus* and *C. capensis* var. *polyanthemus* were placed (correctly) in sect. *Bulbocaulis*. The type collection of *C. capensis* var. *polyanthemus* is immature, so that it is not surprising that he grouped it under *C. capensis* rather than under *C. bullatus*. However, he distinguished *C. bullatus* from *C. capensis* on the grounds of subterete versus trigonous mature spikelets, but this distinction breaks down as the type of *C. bullatus* has distinctly trigonous spikelets. In fact, this species shows remarkably little morphological variation through its wide distribution range.

Recent collections in northern Transvaal have filled in gaps in the known distribution range, and it is now clear that *M. chersinus* is distributed from the Caprivi area, throughout central Botswana, southern Zimbabwe, northern Transvaal, southern Mozambique to northern Natal (Fig. 13), practically reaching the Indian Ocean coast (Fig. 14). Up to now it has only been found in tall, open savanna on deep, loose sand.

The type specimen of *M. angularis* Turrill [Schonland 3848 (GRA, holo.!)] is a typical example of *M. macrocarpus* Kunth with several flowers to a spikelet. It falls in the subgenus *Umbellati* on account of its spherical, woody base. It is difficult to understand how Kükenth could associate this specimen with *M. chersinus* (as *Cyperus chersinus* var. *angularis*), as that species has 1-flowered spikelets and a lanceolate pseudo-bulb, and was at that stage known only from hundreds of kilometres away in Botswana.

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FIG. 13.—*Mariscus chersinus*. Portion of a mature umbel of Vorster 2637, from Sihangwane in northern Natal. Scale = 50 mm.

THE IDENTITY AND TYPIFICATION OF *MARISCUS DREGEANUS*

Mariscus dregeanus Kunth, *Enum.* 2: 120 (1837) has for many years been regarded as a synonym of *M. dubius* (Rottb.) Kükenth., e.g. by C. B. Clarke in *Fl. Brit. Ind.* 6: 620 (1893); in *Fl. Cap.* 7: 187 (1897); in *Fl. Trop. Afr.* 8: 380 (1902); Kükenth in *Pflanzenr.* 101, 4, 20: 563 (1936); Hutchinson in *Fl. W. Trop. Afr.* ed. 1, 2: 485 (1936); Chermeson in *Fl. Madag.* 29: 24 (1937); Hooper in *Fl. W. Trop. Afr.* ed. 2, 3: 295 (1972); Gordon-Gray in Ross, *Flora of Natal* 106 (1972) and Kern in Van Steenis, *Fl. Males.*

ser. 1, 7: 643 (1974). Examination of the original description and type material has, however, revealed that *M. dregeanus* differs from *M. dubius*. The misconception could have arisen in two ways:

1. The two species have a superficial resemblance to each other in the dried condition, and could mistakenly have been considered to be mere variants of the same variable species. It is known that material of the two species is mixed in numerous herbaria.

2. The wrong specimens could have been interpreted to be the type collection of *M. dregeanus*. It is conceivable that any Drège specimen from eastern South Africa conforming more or less to the description of *M. dubius* could be interpreted as being the material Kunth referred to as 'Africae australis ora orientalis', Drège s.n. I have seen two such specimens: one of the two sheets of Drège 4383 in B contains two specimens from 'Basche', of which the two right-hand inflorescences represent *M. dubius* (the two left-hand inflorescences are *M. dregeanus*). A second sheet of *M. dubius* in B is annotated 'no. 4383 intermixt . . . Ora orientalis Africae australis . . . Draege'. Unfortunately I have not had the opportunity to search through the collections at K, L and P for specimens which could have influenced the various authors cited above to arrive at their conclusions, but both sheets of Drège 4383 in B as well as the sheet of *M. dubius* ('no. 4383 intermixt') bear labels written up by Clarke as *M. dregeanus*. It would seem, therefore, as if Clarke at that time (1893) was unable to distinguish between *M. dregeanus* and *M. dubius*.



FIG. 15.—*Mariscus dregeanus*. Lectotype, Drège 4383, in B, with enlargement of the inflorescence. Scale adjacent inflorescence = 20 mm.

The original description of *M. dregeanus* contains the phrase 'spicis compositis subquinis, fasciculato-congestis, sessilibus', which clearly characterizes *M. dregeanus*. The specimen of Drège 4383 in B which is accepted here as lectotype (Fig. 15), has been chosen for the following reasons:

1. It has the multifid spike so typical of this species, and which is mentioned in the original description.
2. The sheet bears an old inscription '*Mariscus Dregeanus* Kth.' and '*Ora orientalis Africae australis* . . .' which is almost identical to the locality note accompanying the original description.

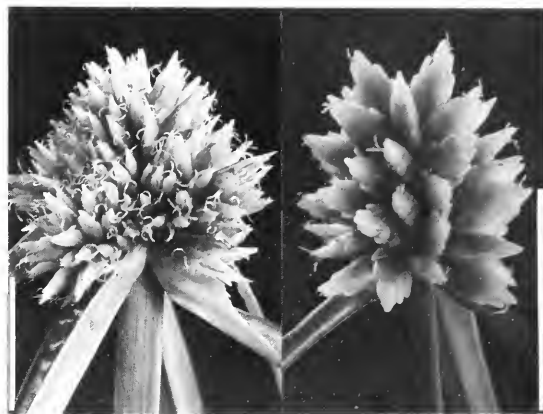


FIG. 16.—Inflorescence of *Mariscus dregeanus* (left, from Vorster 2526 from near Warmbad, Transvaal) and *M. dubius* (right, from Vorster 2492 from St Lucia Bay). Scale bars = 10 mm.

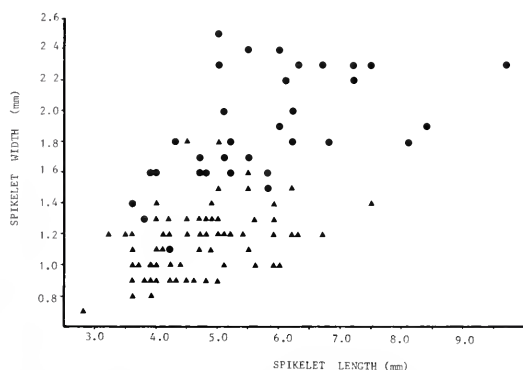


FIG. 17.—Scatter diagram comparing spikelet dimensions in *Mariscus dregeanus* (▲) and *M. dubius* (●).

TABLE 1.—Comparison of some characters of *Mariscus dregeanus* and *M. dubius*

Characters	<i>M. dregeanus</i>	<i>M. dubius</i>
Inflorescence:		
<i>Morphology</i>	A multifid head-like structure	Mostly a single unbranched, obtusely conical spike
<i>Colour in life</i>	Green in all developmental stages	Bright white in all developmental stages
Spikelet:		
<i>Shape</i>	Ovate-lanceolate, hardly compressed laterally	Narrowly ovate, strongly compressed laterally
<i>Dimensions</i>	4.0–6.0 (4.8) × 1.1–1.5 (1.3) mm	4.6–6.8 (5.5) × 1.7–3.0 (2.2) mm
<i>No. of flowers</i>	3–5 (4)	6–10 (17)
<i>Glume:</i>		
<i>Length</i>	2.5–3.5 (3.0) mm	2.6–3.8 (3.2) mm
<i>No. of secondary longitudinal veins</i>	12–16 (14)	16–22 (18)
<i>Length of anther</i>	0.7–0.8 (0.8) mm	0.5–0.8 (0.7) mm
Fruit:		
<i>Shape</i>	narrowly elliptic to obovate	obovate
<i>Dimensions</i>	1.4–1.6 (1.5) × 0.7–0.8 (0.8) mm	1.2–1.4 (1.3) × 0.8–1.0 (0.9) mm

3. The sheet is labelled 'Hb. Kunth', and is thus likely to have been used by Kunth when he described *M. dregeanus*.

Inflorescences of both species dry to a straw-

colour, but the two species can readily be distinguished from each by the characters given in Table 1 (see also Figs 16 & 17).

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THE CORRECT AUTHOR CITATION FOR *CYPERUS ELEPHANTINUS*

Both Kükenthal in Pflanzenr. 101, 4, 20: 51 (1936) and Gordon-Gray in Ross, Flora of Natal 103 (1972) used the name *Cyperus elephantinus* C. B. Cl. (1895). However *C. elephantinus* C. B. Cl. is a *nomen nudum* and therefore illegitimate. The first validly published name given to the species was *Mariscus elephantinus* C. B. Cl. in Flora Capensis 7: 195 (1897), where a full description was provided. In 1909 C. B. Clarke in Illustr. Cyper. t. 20, figs. 1 & 2 again used the name *Cyperus elephantinus*, but this cannot be accepted as valid publication of the name of a new combination under *Cyperus*, since there is

no description or a reference to the basionym, *Mariscus elephantinus*. It was not until 1936 that the combination was validly published: Kükenthal (*l.c.*) published the combination *Cyperus elephantinus*, providing a full Latin description and citing *Mariscus elephantinus*. Although Kükenthal did not deliberately make the combination *Cyperus elephantinus*, it was nevertheless effected and should be accepted. The correct author citation is therefore *Cyperus elephantinus* (C. B. Cl.) Kükenth.

P. J. VORSTER

ERICACEAE

TWO NEW SPECIES OF ERICOIDEAE

Erica insignis E. G. H. Oliver, sp. nov. in genere singularis et facile recognita combination trium characterum: corolla redactissima aspectu aliquot coronae parvae circum ovarium, segmentis calycis maximis et staminibus bene exsertis 6–8plo corolla longioribus; ab *Erica nabea* Guthrie & Bol., specie altera generis exhibente corollam redactam, staminibus bene exsertis, floribus multo majoribus et habitu statim dignoscenda.

Fruticulus ad 400 mm altus, caudice lignoso. *Rami* erecti pubescentes. *Folia* 3nata erecta imbricata parum falcata, 8–12 mm longa, linearia ad angustissime ovata, acuta ad obtusa, parum alata ad basim, sulcata carinataque, statu iuvenili omnino puberula, et ciliata glandulis minutissimis subsessilibus, minus pubescentia vetustate; petiolo 1.5–2 mm longo, pubescente glandulo-ciliatoque. *Flores* 2–3nati ad extrema ramorum et/vel 1–3nati ad extrema ramulorum lateralium; pedicellis 1.3–3 mm longis, dense pubescentibus; bracteolis 3 approximatis subaequalibus aut aequalibus, 8.5–9 × 3–4 mm, duabus lateralibus asymmetricis, omnibus ovato-attenuatis acutis, sulcatis carinatisque in parte 3/4 superiore, sparse et minutissime puberulis, densiore puberulis ad basim, sparse ciliatis glandulis minutis subsessilibus. *Calyx* 4partitus bicyclis, segmentis exterioribus ab- et adaxialibus, 18–24 × 6–7 mm, segmentis interioribus lateralibus 16–20 × 5 mm, omnibus anguste ovato-acutis, carinatis sulcatisque in parte 1/4 superiore, naviculatis, sparse et minutissime puberulis utrinque, sparse ciliatis glandulis minutis subsessilibus. *Corolla* 4lobata 4–5plo calyce breviora 4.5 × 4.5 mm oblato-urceolata, 4saccata et profunde canaliculata sub interstitiis, glabra; lobis filamenta amplexantibus, emarginatis, breviter ciliatis. *Stamina* 8 libera exserta; filamentis elongato-linearibus, 25–32 × 0.5 mm, glabris; antheris 2.7–3 mm longis, oblongis obtusis, parum prognathis rotundisque vel parum bilobatis ad basim, muticis glabris; poro 1.8 mm longo; polline in tetradis. *Ovarium* 4loculare, ovulis multis, breviter cylindraceum, 2.5–3 × 2–2.5 mm, manifestum ad interstitia corollae, 8sulcatum glabrum, crista conspicua similis coronae apice immerso; stylo 30–37 mm longo tereti, longe exserto glabro; stigmatibus capitellato. *Fructus* ad 5 mm longus, capsula loculicidalis, valvis quattuor cucullatis.

TYPE.—Cape, Prince Albert District, northern slopes of Kangoberg in the Great Swartberg Range, 1 400 m, December 1979, *Oliver* 7469 (STE, holo.; K; NBG; PRE).

Dwarf woody shrub up to 40 cm often small and bonsai-like with a woody rootstock. *Branches* erect, pubescent with spreading white hairs. *Leaves* 3-nate, erect imbricate slightly falcate 8–12 mm long, linear to very narrowly ovate, with acute to obtuse red apex and slight wings towards the base, sulcate and carinate, puberulous all over when young and ciliate with minute subsessile glands becoming less so with age; petiole 1.5–2 mm long, pubescent and gland-ciliate. *Flowers* 2–3-nate at the ends of branches and/or 1–3-nate at the ends of short lateral branchlets sometimes becoming crowded towards the ends of branches; pedicels 1.3–3 mm long, densely pubescent; bracteoles 3 approximate, subequal to equal 8.5–9 × 3–4 mm with the two laterals asymmetrical, all ovate-attenuate to broadly ovate and more markedly attenuate, acute, sulcate and carinate in the upper 2/3, sparsely and very minutely puberulous, denser towards the base, sparsely edged with minute subsessile glands, pale green turning bright red. *Calyx* 4-partite, 2-ranked the outer two ad- and abaxial, 18–24 × 6–7 mm, the inner two lateral 16–20 × 5 mm, all narrowly ovate-acute, carinate and sulcate in the upper 1/4, boat-shaped, sparsely and very minutely puberulous on both surfaces, sparsely edged with minute subsessile glands, pale green turning bright red. *Corolla* 4-lobed 4–5 × shorter than the calyx and only just exceeding the ovary, 4.5 × 4.5 mm broadly oblate urceolate, 4-pouched and deeply channelled below the interstices, glabrous, pale green; lobes clasping the relatively large filaments, emarginate, shortly ciliate-edged. *Stamens* 8, free, exserted; filaments elongate linear 25–32 × 0.5 mm, glabrous, pale green; anthers 2.7–3.0 mm long, oblong obtuse, slightly prognathous and rounded or slightly bilobed at the base, muticous, glabrous, pale brown; pore 1.8 mm; pollen in tetrads. *Ovary* 4-celled with numerous ovules, 2.5–3 × 2–2.5 mm shortly cylindric just visible above the corolla interstices, 8-grooved, with conspicuous corona-like ridge with 8 bumps, apex and stigma attachment sunken, glabrous, pale green; style 30–37 mm terete, far exserted, glabrous, pale green; stigma capitellate,

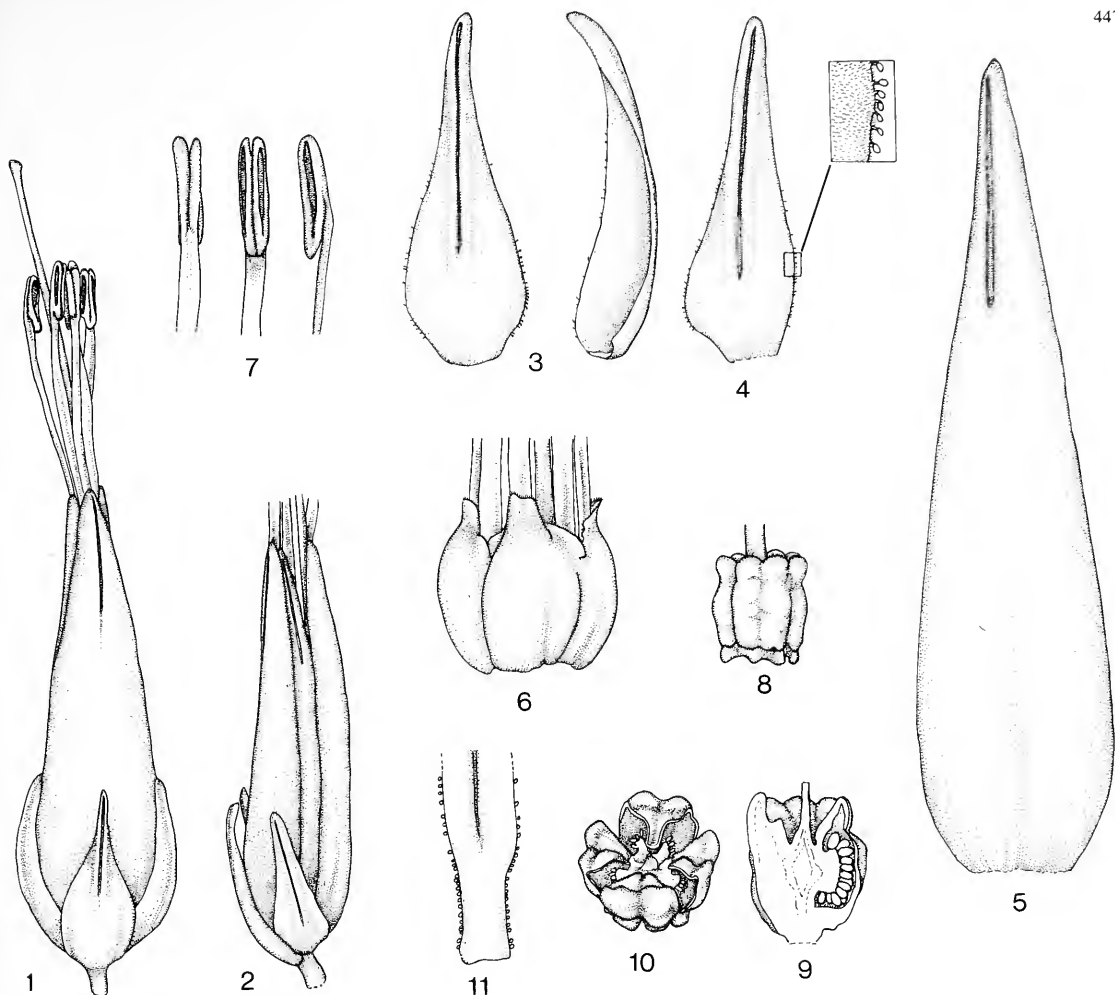


FIG. 18.—*Erica insignis*. 1, flower, abaxial view; 2, flower, lat. view; both $\times 3$; 3, medium bracteole, outer and side views; 4, lateral bracteole; 5, abaxial sepal; 6, corolla; 7, anther, rear, front and side views; 8, ovary; all $\times 6$; 9, young fruit in longitudinal section; 10, mature fruit seen from above; 11, base of leaf, $\times 12$. All drawn from the holotype, *Oliver 7469* (STE).

black. Fruit up to 5 mm long, loculicidal capsule with 4 hooded valves. Fig. 18.

CAPE.—3321 (Ladismith): Swartberg, upper north slopes of Kangoberg (—BD), *Taylor 1102* (BOL); *Oliver 7469* (K; NBG; PRE; STE). 3322 (Oudtshoorn): Swartberg Pass, lower northern slopes (—AC), *Bond 1676* (PRE); *Oliver 7463* (NGB; STE); Swartberg Pass Mountains, upper north slopes without precise locality, *Stokoe 6408* (BM; BOL).

This remarkable species is very distinct in the genus for its very reduced corolla which appears almost like a corona around the ovary, its extremely large calyx segments and for its far exserted stamens four to five times the length of the corolla.

The extremely reduced corolla is not unique in the genus, as it is shared with only one other species, *Erica nabea* Guth. & Bol., which is a species of uncertain position in the Ericoideae. It was originally placed in a monotypic genus as *Macnabia montana* by Lehman on account of the floral arrangement, but was included under *Erica* by Guthrie and Bolus (1905) in *Flora Capensis*. Their view may have to be reversed when my investigations of the generic delimitation within the Ericoideae, at present in progress, are finally completed. For the time being, it is best to accept that *Erica nabea* belongs to the genus

Erica in the section *Adelopetalum* and therefore the new species, *Erica insignis*, as well.

E. insignis, although possessing a basic floral pattern like *E. nabea*, can easily be separated from it. *E. nabea* occurs on the moist coastal flats and southern slopes of the George-Knysna-Uitenhage Districts and is an erect single stemmed shrub up to 1.5 m high with virgate branches. It has smaller whitish green flowers (sepals 14–16 mm long), which are usually arranged in dense pseudoracemes. The stamens are included, the corolla is subovoid, the ovary oblong obtuse and the seeds are flat and broadly winged. *E. insignis* on the other hand occurs in very dry rocky habitats on the northern slopes of the Great Swartberg and is often a gnarled bonsai-like shrublet up to 0.4 m high. It has larger bright red flowers (sepals 18–24 mm long), which are aggregated towards the ends of branches, but never in dense long pseudoracemes. The stamens in *E. insignis* are well exserted, the corolla is broadly oblate-urceolate and 4-channelled, the ovary is shortly cylindrical with a sunken apex and the seeds are not winged.

Despite the above clear differences between the two species there is an overall similarity, which would

suggest some closer relationship somewhere during their evolution. But their widely separated distribution ranges and habitat preferences will remain difficult to explain.

E. insignis has for many years remained an elusive subject for me. It was discovered as early as 1935 by that veteran mountaineer and collector, T. P. Stokoe. A postcard written by him to N. S. Pillans and attached to his collection in the Bolus Herbarium is worth quoting 'My Swartberg trip produced nothing exciting, a few phylica and Erica of the 7 weeks Poort Mountain Type. I found an Erica, Petiveri like in Type but I do not think it is it. *Rock Erica*, faces the blazing north sun pale greeny yellow when young but vivid scarlet as it reaches fruiting stage alt. 5 000 ft. flowers are not pendent but at right angles to stem'. Little did he realize what problems this species would create. Then in 1954 H. C. Taylor recollected the species at 5 000 ft on a high altitude traverse of a number of peaks.

Since the early 1960s, I have visited the Great Swartberg in the vicinity of the pass about ten times, twice with Taylor, and have covered most of the northern slopes on high altitude traverses from Gamkaskloof in the west to Tierberg in the east without finding the species.

Just before leaving in 1979 on another attempt to find it, I received a recent collection of Ericaceae from W. Bond of Saasveld and among them was the species collected not at 5 000 ft, but at 3 000 ft at the base of the Swartberg. En route to the upper slopes of the Kangoberg, I recollected the species at Bond's locality at the foot of the pass. This immediately gave the clue as to its habitat preferences — bare open rocks facing north to west at the extreme lower limit of the fynbos and Table Mountain Sandstone (TMS). Here, it was growing with such unlikely species as *Portulacaria afra*, *Cotyledon orbiculata* and *Passerina* sp.

The visit to Kangoberg revealed a similar situation. The species was found not at high altitude but on the steep very rocky lower slopes at the lowest limit of the fynbos and TMS formation just above the renosterveld and uppermost karroid elements on the shales. Again it was growing in rock crevices with very little or apparently no soil facing north to west and associated with dry elements of fynbos vegetation. The species was definitely not a member of the high montane fynbos vegetation.

The shrublets were very much 'bonsaied' with the rather few branches arising from a gnarled woody rootstock which was pressed into the rock crevices or spread over the rock surface. Occasionally plants grew on flat rock surfaces where soil could accumulate and were more robust and floriferous. It is remarkable that the plants were able to survive in this environment facing the blazing hot sun for much of the day. The flowers when young are pale green, but soon turn bright red when fully exposed to the sun therefore adding to the striking appearance of the plants.

There appears to be little variation of significance in the material available. The hairiness is extremely fine and sometimes sparse and may easily be overlooked. The fruit, like all ericoid fruits, is loculicidal. It exhibits xerochastic movements connected with seed dispersal. The hooded valves open in a dry atmosphere and close on being moistened and therefore the seeds will only be released in dry sunny weather when they can easily be dispersed by the wind.

Scyphogyne calcicola E. G. H. Oliver, sp. nov. in genere distincta et sejuncta propter locum et ecologiam sed quasi accedens *S. divaricatam* Benth., speciem montium Caledonensium et Worcesterensium a qua absentia glandularum, floribus terminaliter aggregatis subglabris et ovario glabro differt.

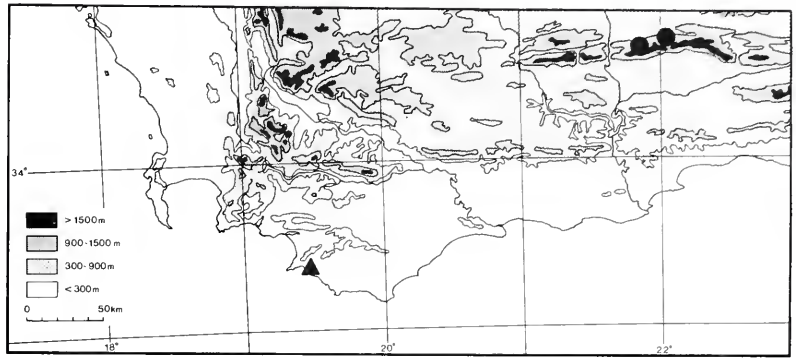
Fruticulus compactus erectus ad 300 mm altus valide lignosus. *Rami* fastigiati virgati foliis solum versus apices instructi, minute pubescentes, trigoni, vetiores notabile articulati. *Folia* 3nata erecta incurva subimbricata, 1,4–2 mm longa, elliptica ad ovata, acuta ad subacuminata, complanata pubescentia ad basim adaxialem, convexa sulcata glabraque in facie abaxiali, marginibus minute serratis hyalinis. *Flores* (3) 6 (8)nati congesti versus apices ramorum vel 2–3nati in ramulis brevibus lateralibus inferioribus, apparente sessiles. *Calyx* 4lobatus inaequalis, interstitia corollae contingens; lobis latissime ovatis obtusis, omnibus subcucullatis in parte superiore, glabris, infra ciliatis supra denticulatis. *Corolla* 4lobata, 1,5–1,7 mm longa obconica ad cyathiformis glabra; lobis latissimis 0,5 mm longis protuberantibus inter lobos calycis, inaequaliter crenatis. *Stamina* 4, connata usque ad medias antheras; tubo filamentorum \pm 0,4 mm longo glabro; antheris 1 mm longis ellipticis obtusis glabris muticis inclusis aut manifestis; poro fere usque ad medium thecam; polline in tetradis. *Ovarium* 1-loculare, 1-ovulatum, glabrum 0,5 mm longum ellipsoideum; stylo 0,9 mm longo glabro, 4porcato; stigmatibus 1,3 mm lato, late infundibuliformi, exserto, relative giganteo et conspicuissimo glabro rubro. *Fructus* incognitus.

TYPE.—Cape, Bredasdorp District, limestone hills near Heidehof (Awila) just north of Pearly Beach, Feb. 1980. *Oliver* 7604 (STE, holo.; BM; BOL; K; MO; NBG; PRE; S).

Shrublet, compact erect up to 30 cm high, woody. *Branches* numerous fastigiate virgate with leaves only towards apices, minutely pubescent with spreading hairs, trigonous, the older noticeably jointed with conspicuous leaf scars and grey remnants of internodal ridges. *Leaves* 3-nate, erect incurved subimbricate 1,4–2 mm long elliptic to ovate to broadly so, acute or subacuminata, flat and pubescent at base adaxially convex, sulcate and glabrous abaxially, with minutely serrate hyaline margins; petiole 0,5–0,6 mm long, adpressed, shortly ciliate, puberulous adaxially, glabrous abaxially. *Flowers* (3) 6 (8)-nate crowded at ends of branchlets or lower down 2–3-nate on short lateral shoots, apparently sessile. *Calyx* 4-lobed to halfway, unequal, reaching to corolla interstices, the larger one 1,2–1,5 mm long broadly deltoid acute to subacuminata, the smaller ones 1–1,4 mm long very broadly ovate obtuse, all subcucullate in upper half, glabrous, ciliate towards the lower edges, denticulate in upper part, carinate above, green. *Corolla* 4-lobed, 1,5–1,7 mm long obconical to cyathiform, glabrous, green with lobes tinged red; lobes very broad 0,5 mm long, bulging out between calyx lobes, unevenly crenate. *Stamens* 4 connate to halfway up the anthers; filament tube \pm 0,4 mm long glabrous; anthers 1 mm long elliptic obtuse, glabrous, muticous, included to manifest; pore almost $\frac{1}{2}$ length of cell. *Ovary* 1-celled with a single pendulous ovule, glabrous 0,5 mm long ellipsoid; style 0,9 mm long glabrous 4-ridged; stigma 1,3 mm wide broadly funnel-shaped, exserted, relatively very large and conspicuous, glabrous, red. *Fruit* not known. Figs 19 & 20.

CAPE.—3419 (Caledon): Spitzkop, hills near Heidehof (Awila) (—DA), May 1973, *Oliver* 4272 (STE); April 1975 *Oliver* 5818 (E;

FIG. 19.—Distribution of ● *Erica insignis* and of ▲ *Scyphogyne calcicola*.



NBG; PRE; STE; W; Z; Feb 1980, Oliver 7604 (BM; BOL; K; MO; NBG; PRE; S; STE).

The genus *Scyphogyne* at present consists of 18 species which occur on the mountains mostly in the region from the Caledon District in the south to the Cedarberg in the north. Only the very common *S. muscosa* (Ait.) Druce is recorded in the Bredasdorp District from a few localities on the coastal hills where it is associated with fynbos vegetation on acid sandstone. Therefore the discovery of this new species growing on the limestone formations, is of particular interest and hence the specific epithet.

The species was discovered by accident while a survey was being made of the unique series of limestone hills between the Uilenkraal River mouth and Quoin Point. On two subsequent visits to the area to collect better material a thorough search revealed only the single population first discovered. The plants were growing on a fairly steep south-facing slope below small cliff faces. The soil was the

typical light brown sandy soil associated with coastal limestone in the south-western Cape. The surrounding vegetation was very short restiads and equally sized Rutaceae and Fabaceae.

The calcified dunes of the coastal areas of the south-western and southern Cape have only in recent geological times become available for colonization by plants. Being poor in nutrients and well drained, their colonization has been by fynbos elements from the nearby sandstone hills. In many cases speciation has accompanied this colonization. There are some notable examples of this among the typical Cape families, Proteaceae, Restionaceae and Ericaceae. In the Ericaceae there are a number of endemic limestone species. This is particularly so in the genus *Syndesmanthus* which I regard as the most recently evolved genus in the tribe Ericaceae. In the same range of hills there occur several distinct and endemic species of *Erica* — *E. saxicola* Guth. & Bol., *E. gracilipes* Guth. & Bol., *E. calcareophila* E. G. H. Oliver and the remarkable *E. occulta* E. G. H. Oliver which grows out of cracks in the limestone cliffs like a bonsai cypress. The problem of endemism on these limestone formations among typically acid sandstone loving genera is enigmatic. Very little research has been done on this intriguing problem and it is hoped that the recently established Fynbos Biome Project will tackle such problems.

On first examination the material did not appear to belong to the genus *Scyphogyne*, but dissection of numerous flowers in spirit of the more recent collection showed that the species bears all the characters characteristic of the genus namely no bracteoles, an unequal 4-lobed calyx, a 4-lobed corolla, 4 stamens and a 1-celled, 1-ovuled ovary. Only one flower was found to vary from this — it had an ovary with 2 cells and 1 ovule per cell which is characteristic of the genus *Salaxis*.

In the description it is stated that the flowers are 'apparently sessile'. This has been used because it is difficult to decide whether the large swollen region below the calyx is a swollen receptacle or a very short pedicel swollen and merged with the base of the calyx. This condition has been noticed in a number of ebracteate genera with unequal calyces.

The relationship of *S. calcicola* is difficult to determine. As already mentioned, *S. muscosa* is the only other species anywhere near to the limestone hills, but it is a completely different species with a different facies with its scattered almost hidden flowers and its free stamens. In the key *S. calcicola* runs down to a position near *S. divaricata* (Klotzsch) Benth., a species from the high mountains of the Caledon and Worcester Districts.

E. G. H. OLIVER

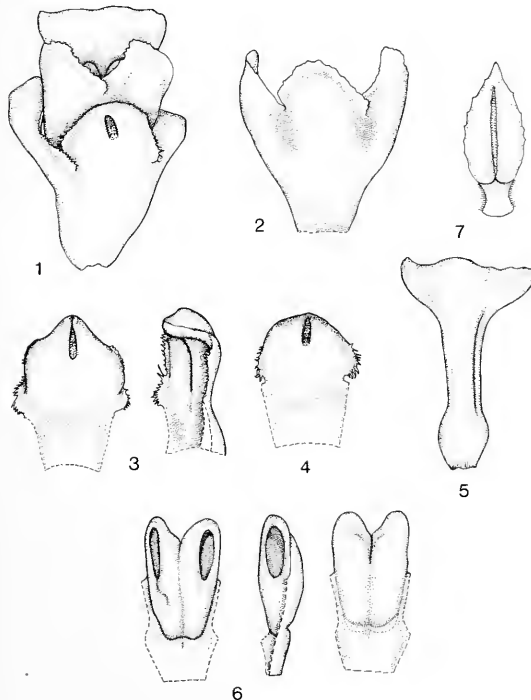


FIG. 20.—*Scyphogyne calcicola*. 1, flower; 2, corolla; 3, abaxial sepal; 4, lateral sepal; 5, gynoecium; 6, anther, front, side and back views; all $\times 25$; 7, leaf, $\times 12.5$. Drawn from the holotype, Oliver 7604 (STE).

ERIOCAULACEAE

A NEW COMBINATION IN *ERIOCAULON*

Eriocaulon dregei Hochst. var. **sonderanum** (Koern.) Oberm. comb. et stat. nov.

E. sonderanum Koern. in *Linnaea* 27: 669 (1854); N. E. Br. in *F. C.* 7: 55 (1897). Type; Transvaal, Magaliesberg, Zeyher 1731 (SAM, iso.), *Burke* s.n. (K!).

Mr R. D. Meikle of Kew has suggested in a personal communication that *E. sonderanum* could be a

variety of *E. dregei*. The present-day ample collections and the types of the names involved support this view. *E. dregei* var. *dregei* appears to be a polyploid. Var. *sonderanum* is the common variety in the Transvaal; in Natal both varieties occur, but in the eastern Cape the larger var. *dregei* becomes common, whereas var. *sonderanum* is rare.

A. A. OBERMEYER

IRIDACEAE

A NEW SPECIES OF *CROCOSMIA*

Crocosmia pearsei Oberm., sp. nov., *C. paniculata* affinis, sed planta solitaria, rhachidi recta non distincte flexuosa (modo dicto anglice 'zig-zag') et floribus majoribus differt.

Cormi tunicae fibrosae. *Planta* ad 1 m alta, decidua, solitaria. *Folia* c. 5 subdisticha, anguste elliptica, apicibus et basibus longe attenuata, c. 500 × 50–70 mm, plicata, basi obliqua, decidua. *Spicus* distichus, erectus simplex vel paucè ramosus, densus. *Spathae* minora ovatae, c. 10 mm longae, apiculatae, brunneae. *Perianthium* aurantiacum, c. 90 mm longum; tubus longus, incurvatus, base angustus,

sensim versus faucem amplius; limbus obliquus, lobi inaequales, lobo superiore grandiore et erecte, 25–30 mm longo. *Stamina* tubo prope basin affixa; antherae lineari-sagittatae, dorsifixae, versatiles. *Ovarium* 3-loculare, ovulis pluris. *Capsula* globosa, c. 7 mm longa (immatura).

TYPE.—Natal, 2829 (Ladysmith): summit of Mnweni Pass in Drakensberg, c. 2900 m (–CC), *R. O. Pearse* 34 (PRE, holo.).

Corm tunicated, fibrous. *Plants* up to 1 m tall, solitary, deciduous. *Leaves* c. 5, distichous, narrowly elliptical, attenuated above and below, c. 500 ×



FIG. 21.—*Crocosmia pearsei*. Pearse 34, sheet I of holotype in PRE.



FIG. 22.—*Crocosmia pearsei*. Pearse 34, sheet II of holotype in PRE.

50–70 mm, plicate, thin but tough, the main nerve placed to one side at the base, deciduous. *Spike* erect, simple or with a short basal side branch; flowers distichously arranged, close together; rhachis straight or showing a faint zig-zag pattern. *Spathe-valves* small, ovate c. 10 mm long, apiculate, brown. *Perianth* orange, c. 90 mm long, with a long curved tube narrow at the base, gradually widening towards the mouth; limb with the upper lobe larger and erect, elliptic, c. 25–30 mm long. *Stamens* attached to the tube near base; anthers linear, sagittate, dorsifixed, versatile. *Ovary* 3-locular, ovules many. *Capsule* globose, c. 7 mm long (immature). Figs 21 & 22.

NATAL.—2829 (Ladysmith): summit of Mweni Pass in Drakensberg, c. 2900 m (—CC), *Pearse* 34 (PRE, holo.). 2828 (Bethlehem): Icidi Pass (—DD), *Gray* s.n. (PRE).

It gives me much pleasure to name this rare *Crocsmia* after Mr R. O. Pearse, the discoverer of this species and the author of 'Mountain Splendour',

a lavishly illustrated book on the flora of the Drakensberg. There is a photograph of this *Crocsmia* (unfortunately captioned No. 3 instead of No. 4 on p. 89 of his book). The species is related to *C. paniculata* (Klatt) Goldbl., but its leaves are annual, not evergreen, the rhachis is more or less straight or only faintly zig-zag and it bears bigger flowers. *C. paniculata* is the common species on the mountain slopes, forming large evergreen colonies. It is therefore understandable that collectors overlooked this elusive solitary plant, probably dismissing it as a young stage of *C. paniculata*. So far it has only been seen twice by Mr Pearse at high altitudes (2 200–3 000 m), where it was flowering in January. Other mountaineers, for instance Mr H. G. Gray, who collected this species on Icidi Pass, also report it as rare.

A. A. OBERMEYER

A NEW SUBSPECIES OF *GLADIOLUS MICROCARPUS*

***Gladiolus microcarpus* Lewis subsp. *italaensis* Oberm.**, subsp. nov., a subsp. typica foliis glabris et rhachidi dense pubescenti differt.

TYPE.—Natal, 2731 (Louwsburg): Itala Nature Reserve (—AC), *Mauve* et al. 5266 (PRE, holo.).

When Lewis in 1966 examined material of *Gladiolus* at PRE, she identified *J. C. Smuts* 2371 from Wakkerstroom, collected in December 1944, as near *G. microcarpus* cf. *Jl S. Afr. Bot.*, Suppl. 10: 87 (1972). In 1976 Messrs Brown and Shapiro undertook a survey of the flora of the Itala Nature Reserve and collected specimens of this species (their No. 411) at the junction of the Thalu and Pongolo Rivers, in a Lowveld type of vegetation. This was the first record of a precise locality and it seemed worthwhile to examine it more closely as the typical material of *G. microcarpus* comes from the Drakensberg at high altitudes, some 200 km to the south or south-west of the localities referred to above. The species therefore appears to have a disjunct distribution. The reserve was visited in January 1980 and more material was obtained from the same area. It was found on a N. W.-facing, steep slope, growing in rock crevices shaded by small trees and shrubs. The flowers were delicate in texture and light pink in colour; the lower lobes had a dark pink midrib flanked by a white area. When fading the pink turns to pale- and later to dark lilac. Although closely related to the typical form, some differences in the pattern of pubescence and the distribution suggest that we are dealing with a subspecies (Fig. 23).

Key to subspecies

- Rhachis and spathes glabrous; leaves with short, patent hairs on the nerves; growing in the Drakensberg at high altitudes, c. 1 800 m above sea-level; plants usually pendulous..... subsp. *microcarpus*
- Rhachis and spathes shortly and densely pubescent; leaves glabrous; growing in Lowveld vegetation, c. 250 m above sea-level; plants erect..... subsp. *italaensis*

LILIACEAE

A NEW VARIETY OF *ALOE* FROM THE VRYHEID DISTRICT

***Aloe reitzii* Reynolds var. *vernalis* Hardy**, var. nov., a varietate typica bracteis floralibus deltoideo-acuminatis, 6×4–5 mm, non lanceolato-acutis 10×7 mm, capsula matura minima 15 mm longa 10 mm

diametro, non 25 mm longa et 14 mm diametro dif-fert.

TYPE.—Natal, Vryheid District, farm 'Oor-spring', 1971-09-10, *Hardy* 3589 (PRE. holo.).



FIG. 23.—*Gladiolus microcarpus* subsp. *italaensis*. Painting of holotype plant, *Mauve* et al. 5266, by R. Holcroft.

The Natal Parks Board and their staff at the Itala Nature Reserve are thanked most sincerely for their kind co-operation.

A. A. OBERMEYER

Plant succulent, acaulescent or rarely with a stem up to 50 cm, the stem procumbent, simple. *Leaves* lanceolate-ensiform, arcuate-erect, densely rosulate, dull green, up to 64 cm long, 5–9 cm broad at the base, the apex armed with a pungent thorn; upper surface flat to slightly concave, smooth, devoid of markings; lower surface convex, smooth or sometimes with thorns in the median line near the apex, the thorns pungent, brownish, about 3 mm long, 5 mm apart, the teeth arising from white bases, the interspaces straight, the same colour as the leaf. *Inflorescence* 70–75 cm high, two to four branched from below the middle. *Peduncle* 3.5–4 cm diam. near the base, naked below the first branch, branches below the racemes clothed with several sterile bracts. *Racemes* cylindric, slightly acuminate, densely multi-flowered, 30–40 cm long, 5–6 cm diam., the buds and flowers pendulous. *Bracts* deltoid-acuminate, 6 mm long by 4–5 mm broad at the base, scarious, brownish, many-nerved, reflexed. *Pedicels* green, 3 mm long. *Perianth* curved-cylindrical, up to 40 mm long, the base rounded, tube 5 mm diam. enlarging to about 7 mm above the middle, narrowing slightly towards the mouth; outer segments connate into a tube for about 25 mm, the free portion 15 mm, the two upper segments bright orange with five red-brown nerves, margins paler, the apices subacute, slightly falcately connivent, the lower segment lemon-yellow with three to five darker coloured nerves, apex subacute, straight; inner segments free but dorsally adnate to the outer to about the middle, with narrow white margins, the upper segment with a 15 mm keel the colour of the perianth becoming brownish at the apex, the two lower segments with a less pronounced keel formed by three greenish nerves. *Filaments* distinctly flattened, the three inner narrower and lengthening in advance of the three outer, pale lemon-yellow within the perianth, the exserted portion brownish-orange. *Anthers* exserted by 8 mm. *Style* a deeper yellow than the filaments, the exserted portion the same brownish-orange colour. *Stigma* becoming exserted by 10 mm. *Ovary* olive-green, 6 mm long, 3 mm diam. at base. *Capsule* 15 mm long, 10 mm diam. Fig. 24.

NATAL.—2730 (Vryheid): farm 'Oorspring' between Vryheid and Natal Spa (—DB), 10 Sept. 1971, Hardy 3589 (PRE).

This interesting variety differs from the typical variety in the following respects: the floral bracts are deltoid-acuminate in shape, 6 mm long by 4–5 mm broad as opposed to lanceolate-acute and 14 mm long by 7 mm broad. The mature capsules are also very much smaller, 15 mm long and 10 mm in diameter compared with 25 mm long and 14 mm diameter in the typical variety.

There are also differences in flowering time and in distribution: var. *reizii* flowers during February and



FIG. 24—*Aloe reizii* var. *vernalis*. Plant in natural habitat on steep, well-drained granitic slopes.

March, whereas var. *vernalis* flowers during the spring months of August and September, hence the varietal epithet. Var. *reizii* has been recorded from three or four localities in the Belfast District of eastern Transvaal, whereas var. *vernalis* is apparently confined to a very small area in the Vryheid District of Natal.

A closely related species, *A. gerstneri* Reynolds, occurs near the Nondweni River south of where *A. reizii* var. *vernalis* occurs and can, when not in flower, be easily confused with the latter; in both the slender leaf marginal teeth arise from distinct white bases, a character not occurring in var. *reizii*. When in flower, however, *A. gerstneri* is readily distinguished by its cylindric-ventricose flowers which are up to 30 mm long.

D. S. HARDY & C. REID

A REAPPRAISAL OF *URGINEA ALTISSIMA*

When discussing the *Urginea epigea*-*Drimia altissima* problem in Bothalia 13: 139 (1980), I had unfortunately omitted to examine the Thunberg type specimen of *Ornithogalum altissimum* L.f. I have since established that it was collected in the eastern Cape at the Zondags River and that it bears its flowers on long patent pedicels Fig. 25. I now realize that it is the widespread summer rainfall region species which is found as far north as tropical Africa. Jessop in J. S. Afr. Bot. 43: 288 (1977) was correct in his interpretation, whereas I was wrong and I apologize. But, like Baker in Fl. Cap. 6: 470 (1897), I prefer to place

it in *Urginea* for it produces white stellate flowers on long patent pedicels.

However, the reference by Jessop to the plate in Curtis's bot. Mag. 27: t. 1074 (1808) is misleading as this depicts a different species, namely the well-known 'Maerman' from the winter rainfall region Fig. 26. This species is recognized by its long, dense spike bearing sessile or nearly sessile flowers. Unfortunately it was wrongly identified as *Urginea altissima* (L.f.) Baker by Adamson & Salter in the Flora of the Cape Peninsula p. 194 (1950) and other



FIG. 25.—Holotype of *Urginea (Ornithogalum) altissima* (L. f.) Bak. (UPS 8275), from eastern Cape.

Cape botanists and it must receive another name. The flowers are somewhat fleshy with tepals that form a shallow cup and recurve above and the stamens are usually coherent at first. Because of this, I prefer to place it in *Drimia*.

***Drimia forsteri* (Bak.) Oberm., comb. nov.**

Urginea forsteri Bak. in Fl. Cap. 6:469 (1897). Types: *Forster* s.n. (K, holo.!); *Cooper* 3275 (K, iso.). Fig. 27.



FIG. 26.—*Drimia forsteri* (Bak.) Oberm. Curtis's bot. Mag 27: t. 1074 (1808), as '*Drimia altissima*'.

Drimia altissima sensu Ker-Gawl. in Curtis's bot. Mag. 27:t. 1074 (1808), non *Ornithogalum altissimum* L.f.

Selected specimens:

CAPE.—3218 (Clanwilliam): Piketberg (—DA), *Marloth* 7692. 3318 (Cape Town): Cape Peninsula, Table Mtn, Apostle Ravine (—CD), *Marloth* 13029; Llandudno (—CD), *Leighton* 458; De Grendel, western slope of Tygerberg hills (—DC), *Boucher* 3516. 3319 (Worcester): Worcester Veld Reserve (—CB), *Olivier* 67. 3422 (Mossel Bay): Mossel Bay (—AA), *Marloth* 7329.



FIG. 27.—Types of *Drimia (Urginea) forsteri* (Bak.) Oberm.: *Forster* (K, holo.!); *Cooper* 3275 (K, iso.).

The Director of the Thunberg Herbarium is thanked for the photograph of the type of *Urginea (Ornithogalum) altissima* (L. f.) Bak. and to the Director of the Royal Botanic Gardens, Kew, thanks are due for the photographs of *Drimia (Urginea) forsteri* (Bak.) Oberm.

Note. *Drimia altissima* Hook. in Curtis's bot. Mag. t. 5522 (1865), non Ker-Gawl., is an entirely different species. It was given the new name, *D. alta* R. A. Dyer in 1943 (Flower. Pl. S. Afr. 23: t. 890). There is however, the older name *Drimia robusta* Bak. in Saund. Ref. bot. t. 190 (1870), which should be adopted for this eastern inland species. It is not the same as *D. elata* Jacq. (cf. Jessop in Jl S. Afr. Bot. 43: 285).

MESEMBRYANTHEACEAE

NOMENCLATURE IN THE GENUS *MESTOKLEMA*

The original description of the genus *Mestoklema* was published on 29 August 1936 in English only (Brown, 1936). This means that the genus and the four new species which Brown described in the same posthumous paper, are all invalidly published in terms of the International Code of Botanical Nomenclature, Article 35, which requires that for all names of new taxa published after 1 January 1935, a Latin diagnosis or description be given. And, since the genus was not validly published, Brown's three new combinations were also not validly published (Article 43).

Latin translations of Brown's original descriptions are given here in order to validate the five names which were not published validly. These descriptions have not been changed except for the measurements, which have been metricated. In the case of the new combinations, Brown's literature citations have been taken over unchanged.

***Mestoklema* N. E. Br. ex Glen**

Mestoklema N. E. Br., Gdnrs' Chron. 100: 164 (1936) descr. anglie.

Frutices vel fruticuli, una specie cum trunco arboriforme, dumaliter, saepe intricate ramificati, aliquando (semper?) radicibus tuberosis; *rami* juvenes minute papulosi, tactu asperiusculi ubi exsiccatis, pallidi; *cymi* perdurantes, indurescentes, subspinescentes neque pungentes. *Folia* opposita, basin non connata, desciscentia saepe prominentiam denticuloidem relinquunt, trigona vel subteretia, minute vel microscopice papulosa micantiaque, cum caespibus foliarum in axillis. *Flores* parvi, pedicellati, in cymis terminalibus bracteatis dichotome 2–5-plo divis. *Bractee* parvae, foliiformes. *Calyx* subaequant 5-lobatus, nonnulli lobi marginis angustis membranaceis. *Petala* uniseriata, linearia, saepe vix longiora quam lobi calycis. *Stamina* multa, conico-collecta, intima barbata; staminodia nulla. *Stigmata* 5, erecta, breviora quam stamina, subulata, fortasse papillata. *Ovarium* semisuperius, conicum vel convexum, superne cristatum, 5-valvatum -loculatumque, valvuli recurvati dum expansi, carinae expansoriae inferne contiguae, superne divergentes, vulgo sordide aurantiacae vel aurantiaco-brunneae, alibus angustulis, acutis, membranaceis, sine tuberculo placentale. *Semini* ovoidei, brunnei, laeves. Type species: *M. tuberosum* (L.) N. E. Br. ex Glen.

***Mestoklema tuberosum* (L.) N. E. Br. ex Glen, comb. nov.**

Mesembryanthemum tuberosum L., Sp. Pl. 484 (1753); Haw., Obs. Gen. Mesemb. 271 (1795); Misc. Nat. 89 (1803); Syn. Pl. Succ. 252 (1812); Rev. Pl. Succ. 179 (1821); Salm Dyck, Monogr. Gen. Aloes Mesemb. 49, t. 2 (1854); Berger, Mesemb. Portulac. 100, fig. 13. III–IV (1908). *Delosperma tuberosum* (L.) Schwant., Möllers dt Gärtn.-Ztg 42: 258 (1927). Iconotype: Dill., Hort. Elth. 275, t. 207, fig. 264 (1732).

M. spinosum O. Kuntze, Rev. Gen. Pl. 3: 109 (1893), non L.

var. *macrorrhizum* (Haw.) N. E. Br. ex Glen, comb. et stat. nov.

Mesembryanthemum macrorrhizum Haw. in Till. Phil. Mag. 1826: 331 (1826); Salm Dyck, Monogr. Gen. Aloes Mesemb. 49, t. 3 (1842); N. E. Br. in J. Linn. Soc., Bot. 45: 121 (1920). Lecto-iconotype: Duncanson watercolour (K!).

M. megarrhizum Don, Gen. Syst. 3: 145 (1834); Sond., Fl. Cap. 2: 441 (1862); Berger, Mesemb. Portulac. 101 (1908).

Brown states that the type is a plant of which Bowie sent tubers to Kew in 1820 from South Africa. The plant itself has disappeared, but there is a Duncanson watercolour of one branch of it still extant at Kew; this is now designated as the lecto-iconotype.

***Mestoklema arboriforme* (Burch.) N. E. Br. ex Glen, comb. nov.**

Mesembryanthemum arboriforme Burch., Trav. 1: 343 (1822); N. E. Br. in J. Linn. Soc., Bot. 45: 124 (1920). Type: Cape, between Wittewater and Rietfontein, Burchell 2004 (K, holo.).

***Mestoklema copiosum* N. E. Br. ex Glen**

Fortasse frutex parvus vel fruticulus, *rami* visi [Brownio—HFG] 150–200 mm longi, inferne 3–4 mm lati, internodiis 4–12 mm longis, juvenili minute papulosi albi, primo cinerascetes, deinde laevescentes brunnescentesque aetate. *Folia* adscendentia-patentia, 10–17 mm longa, ca. 1,5–2 mm crassa, trigona, obtusa, haud vel aegre apiculata, ut videtur superne subcanaliculata, inferne obtusissime carinata, microscopice papulosa. *Cymi* 40–90 mm diametro, 4–5-plo furcati, subdense pluri- (15–50) -florati. *Bractee* 2–4 mm longae, crassae, apice obtusissimae subrecurvatae. *Pedicelli* 2–3 mm longi. *Receptaculum* 2,5–3 mm diametro, perbreve obconicum; lobi calycis 2–3 mm longi, deltaidei. *Corolla* ut videtur ca. 8 mm diametro, petala ca. 3 mm longa, 0,5–0,7 mm lata, obtusa vel acuta. *Stamina* ca. 1,5 mm longa. *Stigmata* 5–7, ca. 0,6–1 mm longa, crassa, acuminata. *Ovarium* superne convexum. *Capsula* 2,5 mm diametro, obconica; cetera ut in descriptione generico.

TYPE.—Cape. Mazelsfontein, Anderson 720 (K, holo.).

***Mestoklema elatum* N. E. Br. ex Glen**

Frutex 60–120 cm altus, *rami* primi adscendentes, inferne 4–6 mm lati, internodiis 10–25 mm longis, juvenili perminute papulosi cinerei; laevescentes brunnescentes aetate; cortex exsiccatus longitudine rugosus. *Folia* adscendentia-patentia vel patentia, 8–15 mm longa, 1,3–1,5 mm crassa, compressa-trigona, superne plana vel subcanaliculata, inferne carinata, apice recurvata, lateraliter visa inferne subacuta vel obtusa, microscopice papulosa. *Cymi* 25–40 mm diametro, dense 15–20 -florati, pedicelli 2–6 mm longi. *Bractee* pusillae, ca. 1–1,5 mm longae, ut videtur mox desciscentes. *Receptaculum* 2,5–3 mm diametro, lobi calycis ca. 1,5 mm longi, deltaidei, obtusi. *Corolla* 6–7 mm diametro; petala vix 2 mm longa, obtusa, 'purpurea' — fortasse color aliquis magenteae. *Stamina* ca. 1,5 mm longa. *Stigmata* vix 1 mm longa. *Capsula* 2,5–3 mm diametro, mox desciscens; cetera ut in descriptione generico.

TYPE.—Cape, between Committees and Hunt's Drift, Dyer 890 (K, holo.).

***Mestoklema illepidum* N. E. Br. ex Glen**

Planta ca. 230–250 mm alta, glabra, multiramosa. *Rami* primi inferne 5–8 mm crassi, internodiis 6–13 mm longis, juvenili minute papulosi, exsiccatis albi, aetate brunnescentes. *Folia* parva, 3–8 mm longa, 1–1,5 mm crassa, compresso-subteretia, obtusa, apice subrecurvata, microscopice papulosa, viridia.

Flores perparvi, in cymis terminalibus bracteatis, bracteis 1–2 mm longis. *Pedicelli* 2–4 mm longi. *Receptaculum* 2–2,5 mm diametro; lobi calycis 1,5 mm longi, deltoidei, obtusi. *Corolla* ut videtur ca. 6 mm diametro; petala 2 mm longa, 0,4–0,5 mm lata, obtusa, 'submagentea'. *Stamina* ca. 1 mm longa, ut videtur alba. *Stigmata* ca. 0,5 mm longa subulata. *Capsula* ca. 3 mm diametro; cetera ut in descriptione generico.

TYPE.—Cape, on the road from Grahamstown to Bedford, *Dyer* 2336 (K, holo.!).

***Mestoklema albanicum* N. E. Br. ex Glen**

Planta ut videtur ca. 230–380 mm alta, glabra. *Rami* primi ut videtur basin decumbentes, deinde erecti vel adscendenti, ramosi, basin 2–3,5 mm lati, internodiis pro parte maxima 13–19 mm longis, juvenili minute papulosi cinerei, laeviscentes brunnescentesque aetate. *Folia* patentia, apice plus minusve recurvata, 6–10 mm longa, 1,5–3 mm crassa, supra ut videtur plana vel subcarinata, infra

obtuse carinata, fortasse compressa, minute papulosa. *Cymi* 25–55 mm diametro, laxi, pedicelli 8–15 mm longi, *Calyx* subaequaliter 5-lobatus, lobi 2–2,5 mm longi, deltoidei, obtusi; receptaculum ca. 3 mm diametro, breve obconicum. *Corolla* ut videtur ca. 7 mm diametro, petala ca. 2,5–3 mm longa, linearia, obtusa, 'submagentea'. *Stamina* ca. 2 mm longa. *Stigmata* ca. 1 mm longa, subulata; ovarium supra convexum. *Capsula* 4–5 mm diametro; cetera ut in descriptione generico.

TYPE.—Cape, 12 km from Grahamstown towards Cradock, *Dyer* 1308 (K, holo.!, PRE, iso.!).

I should like to thank Drs O. A. Leistner and D. J. B. Killick for reading through this manuscript and for their helpful suggestions.

REFERENCE

BROWN, N. E., 1936. *Mesembryanthemum*. *Gdnrs' Chron.* 100: 164–166.

H. F. GLEN

ORCHIDACEAE

NOTES ON SOUTH AFRICAN SPECIES OF *HOLOTHRIX*

***Holothrix filicornis* Immelman & Schelpe**, sp. nov., *H. scopularia* (Lindl.) Reichb. f. affinis, calcar longissimo, foliis scapisque glabris, spica non secundissima differt.

Folia glabra. *Scapus* ebracteatus, glaber, 65–260 mm longus. *Sepala* glabra, ovata, acuta, 1,5–2,0 mm longa, 0,5–1,0 mm lata, ovidi-rubra. *Petala* triloba, 3,0–8,0 mm longa, 0,5–1,0 mm lata, viridi-alba, lobis filiformibus, paulum carnosus. *Labellum* quinquelobum, 4,5–9,0 mm longum, 1,5–2,5 mm latum, viridi-album, lobis filiformibus, paulum carnosus. *Calcar* conicum, dependens vel leviter incurvatum, 7–11 mm longum.

TYPE.—Cape, 2917 (Springbok): 23 km west of Springbok (–DB), *Acoccks* 19269 (BOL, holo.; PRE; K).

Leaves glabrous. *Scape* glabrous, without bracts, 65–260 mm long. *Ovary* twisted, green tinged with red. *Sepals* glabrous, ovate, acute, 1,5–2,0 × 0,5–1,0 mm, green tinged with red. *Petals* with three filiform, slightly carnosous lobes comprising $\frac{1}{2}$ – $\frac{2}{3}$ of the total petal length, 3,0–8,0 × 0,5–1,0 mm, white tinged with green. *Lip* slightly carnosous, divided into five filiform lobes, lobes comprising $\frac{2}{3}$ – $\frac{3}{4}$ of the total lip length, lip 4,5–9,0 × 1,5–2,5 mm, greenish white. *Spur* conical, curved, pendulous, 1,25–2,0 times the length of the lip, 7–11 mm long.

This species appears to be confined to northern Namaqualand. It grows in rock crevices and on stony slopes; flowering from June to September.

CAPE.—2816 (Oranjemund); south-western Richtersveld (–BB) *Williamson* 2562 (BOL); *Williamson* 2565 (BOL). 2817 (Vioolsdrif); north-east end of Paradysberg (–AC), *Tölken* 3293 (BOL); Richtersveld, Stinkfontein, south-west of Zylsus, upper eastern slopes on summit of ridge (–CA), *Oliver, Tölken & Venter* 652; Richtersveld, Cornelsberg in Stinkfontein mountains, in main large kloof, on east side below beacon (–CA), *Oliver, Tölken & Venter* 702. 2917 (Springbok): Richtersveld, Karoogapoort, 9 km south of Lekkersing, main hill north of poort, on north side (–AA), *Oliver, Tölken & Venter* 823; 23 km west of Springbok (–DB), *Acoccks* 19269 (BOL; PRE; K).

H. filicornis appears to be most closely related to *H. scopularia* among the *Holothrix* species in South Africa, both having 3-lobed petals and a bractless scape. The petals in all other species with divided petals have a variable number of lobes. However, *H.*

scopularia is a high-montane species from the Drakensberg, and the two are also easily distinguished on the basis of the long spur, the glabrous leaves and scape, and the less strongly secund spike of *H. filicornis*.

The most striking character of this species is the relatively very long spur. Unfortunately the specific epithet *longicornu* has already been used in the genus, and so *filicornis* was chosen instead.

***Holothrix brevipetala* Immelman & Schelpe**, sp. nov., *H. cernua* (Burm. f.) Schelpe affinis, petalis brevibus, lobis labii brevioribus et latioribus differt.

H. hispidula sensu Bolus, Ic. Orch. Austro-Afr. 3: t. 17 (1913) partly, excl. syn. L. f., Thunb.; Orch. Cape Penins. ed. 2: 20, t. 13 (1918) partly, excl. syn. L. f., Thunb.; Schltr. in Öst. bot. Z. (1898) 443, partly, excl. syn. L. f., Thunb.; non (L. f.) Dur. & Schinz.

H. parvifolia sensu Rolfe in Fl. Cap. 5: 3: 103 (1913) partly, excl. syn. Thunb.; Bolus, Orch. Cape Penins. ed. 1: 115, t. 24 (1888); non Lindl.

Folia squamellis vel pilis crassis dense vestita. *Scapus* ebracteatus, crassus, 60–300 mm longus, pilis hispidis reflexis. *Sepala* dense pilosa, ovata, acuta, 1,0–2,5 mm longa, 0,5–1,5 mm lata, luteo-viridia, ad apicem carnososa. *Labellum* trilobum vel quinquelobum, 2,5–3,5 mm longum et latum, luteo-viride, interdum verrucosum (necnon petalum), lobis brevibus latis carnosus. *Calcar* conicum, leviter incurvatum, 1–2 mm longum.

TYPE.—Cape, 3324 (Steytlerville): Humansdorp, koppie above Oudebos (–CC), *Jeppie* in PRE 33391; holo., K).

Leaves densely covered with small squamules or stout hairs, sometimes withered at flowering. *Scape* with short, hispid, reflexed hairs, without bracts, stout, 60–310 mm. *Sepals* densely pilose, 1,0–2,5 mm. *Petals* undivided, carnosous at the apices, 2,5–3,5 × 0,5–1,5 mm, yellow-green. *Lip* carnosous, lip and petals sometimes warty, lip oval in shape with 3–5 short, broad lobes, 2,5–3,5 × 2,0–3,5 mm, yellow-green. *Spur* conical, slightly curved, 1,0–2,0 mm.

H. brevipetala occurs in the south-western Cape and in the southern Cape areas towards Port Eliza-

beth. It grows in sand and in shallow soil in rock-crevices and, though it can be found in flower from August to April, it usually flowers between October and January.

CAPE.—3318 (Cape Town): Waai Vlei, *Wolley-Dod* 2339 (BOL); Table Mountain summit, near Klaassenbosch (—CD), *Bolus & Scully s.n.* (BOL; SAM); Top of Nursery Buttress (—CD), *Bryans* 141/75 (NBG); Table Mountain, Echo Valley (—CD), *Compton* 8284 (NBG); Table Mountain, between Skeleton and Window Gorge (—CD), *Leighton* 750 (BOL); Table Mountain, summit (—CD), *Schlechter* 464 (BOL). 3319 (Worcester): near Elgin, between Grabouw and Paardeberg, (—AC), *Stokoe s.n.* (SAM); Paarl, Slanghoek mountains, Witteberg, northern-western side (—CA), *Wasserfall* 605 (NBG). 3324 (Steytlerville): (—CC), *Jepe* in *PRE* 33391. 3326 (Grahamstown): Coldstream (—BC), *Glass s.n.* (PRE). 3418 (Simonstown): Constantiaberg (—AB), *Compton* 15466 (NBG); Cape Point, Smith's Farm (—AD), *Compton* 6067 (NBG); mountain above Smits-winkelbaai (—AD), *Schlechter* 667 (BOL). 3419 (Caledon): Palmiet River Mountains, *Stokoe s.n.* (SAM). 3420 (Bredasdorp): Heidelberg, Naauwpoort Peak (—BB), *Thorn s.n.* (SAM). 3423 (Knysna): Knysna (—AA), *Duthie s.n.* (BOL.) 3424 (Humansdorp); Tsitsikama, Ratel's Bosch, flats below road, *Fourcade* 583 (GRA).

This species has been misidentified as *H. hispidula* (L. f.) Dur. & Schinz which is based on *Sparrmann* 34 (LINN!); and as *H. parvifolia* Lindl., a superfluous name for *H. hispidula*. Both these names must be included as synonyms of the species *H. cernua* (Burm. f.) Schelpe, and a new name chosen for the species referred to by Bolus, Rolfe, Schlechter and other authors. *H. brevipetala* has been chosen because the species has short, broad petals (and lip-lobes) which characterize it and distinguish it from its close ally *H. cernua*.

***H. villosa* Lindl. var. *condensata* (Sond.) Immelman, stat. et comb. nov.**

H. condensata Sond. in *Linnaea* 19:76 (1848). Type: Cape, 3420 (Bredasdorp); Swellendam, in sand dunes (—AB), *Mund s.n.* (S; K).

H. lithophila Schltr. in *Öst. bot. Z.* (1898) 446; Engl. in *Bot. Jb.* 26: 331 (1898). Type: Cape, 3419 (Caledon): on mountain above Vogelgat lagoon (—AD), *Schlechter* 9556 (B†; one flower at K).

A number of characters appeared at first to separate *H. condensata* from *H. villosa*, i.e. denser spike, larger flowers and leaves, stouter scape, broader lip-lobes and longer, broader petals. However, on closer examination, these characters were all found to intergrade or at least to overlap. In their 'typical' forms the two taxa are separable, but numerous intermediate specimens make it difficult to uphold *H. condensata* as a separate species.

The distribution ranges of the two varieties overlap, with *H. condensata* tending to occupy damper habitats, and occurring almost exclusively (but not quite: see type) in rock crevices and on cliffs. *H. villosa* is also found in rock crevices but does occur frequently in other habitats, in fynbos, grassland, semi-arid areas, sandy areas under young wattles, and on roadsides. There is no difference in flowering time. *H. condensata* is therefore reduced to a variety of *H. villosa*.

***Holothrix parviflora* (Lindl.) Reichb. f. in Otia Bot. Hamb. 2: 119 (1881). Type: Cape, 3323 (Willowmore); Swanepoelport Mountains (—BB), *Drège* 8276a (K).**

Tryphia parviflora Lindl. in Hook. Comp. bot. Mag. 2: 209 (1836).

T. secunda Lindl. in Hook. Comp. bot. Mag. 2: 209 (1836), non *Orchis secunda* Thunb. (1823). Type: Cape, 73322 (Oudtshoorn); Koratra (Karataka?) (—DD), *Drège s.m.* (K).

Holothrix lindleyana Reichb. f. in Otia Bot. Hamb. 2: 119 (1881). Type: as for *T. secunda* Lindl.

H. G. Reichenbach considered *Tryphia parviflora* Lindl. to be a separate species from *T. secunda* when he transferred both to *Holothrix*. However, the epithet *secunda* could not be used because of the existence of *H. secunda* (Thunb.) Reichb. f. (1823), and so he gave the species a new name, *H. lindleyana* Reichb. f.

T. parviflora was described by Lindley from a specimen said to differ from *T. secunda* Lindl. in being half the height and having flowers one quarter the size of *T. secunda*. The greater range of material available today shows that the two are linked by intermediate specimens and they are considered to be conspecific. The name *H. lindleyana* is therefore superfluous.

***H. incurva* Lindl. in Hook. Comp. bot. Mag. 2: 207 (1836).**

H. rupicola Schltr. in *Bot. Jb.* 24: 419 (1897) syn. nov. Syn-types: summit of Mont-aux-Sources, *Thode* 6 (not seen), slopes of Mont-aux-Sources, *Flanagan* 11981 (BOL!).

***H. scopularia* (Lindl.) Reichb. f. in Otia Bot. Hamb. 2: 119 (1881).**

H. multisecta H. Bol. in *J. Linn. Soc. Bot.* 25: 170, 190, fig. 7 (1890), syn. nov. Type: Stockenström, Elandsberg summit, *Scully* 391 (K; BOL!).

***H. aspera* (Lindl.) Reichb. f. in Otia Bot. Hamb. 2: 119 (1881).**

H. confusa Rolfe in *F. C.* 5, 3: 105 (1913), syn. nov. Syntypes: mountain sides about Clanwilliam, *Leipoldt* sub *MacOwan* & *Bolus s.n.* (Herb. Norm. Aust. 1757); Blaauwberg, *Schlechter* 8465 (K; BOL!); near Oliphant's River Mountains, *Schlechter* 5036 (K); near Piekensklouf and near Modderfontein, *Schlechter* 5077 (not seen); Hex River Valley, *Wolley-Dod* 4054 (K; BOL!).

***H. exilis* Lindl., Gen. et Sp. Orch. 283 (1835).**

H. exilis var. *brachylabris* (Sond.) H. Bol., *lc. Orch. Austro-Afr.* 1: t.14, fig. A (1896), syn. nov. Type: Uitenhage, *Zeyher s.n.* (K).

***H. cernua* (Burm. f.) Schelpe in Orchid Rev. 74: 394 (1966).**

H. squamulosa Lindl. var. *scabra* Bol. in *Trans. S. Afr. phil. Soc.* 5, 1: 114, t.23a (1888), syn. nov. Type: Cape Flats, sometimes on old thatched roofs near Rondebosch, *Bolus* 7022a (BOL!).

H. squamulosa Lindl. var. *hirsuta* H. Bol. *ibid.*, syn. nov. Type: locality as above, *Bolus* 7022b (K; BOL!).

H. squamulosa Lindl. var. *glabra* H. Bol. *ibid.*, syn. nov. Type: locality as above, *Bolus* 7022c (K; BOL!).

***H. culveri* H. Bol. in Trans. S. Afr. phil. Soc. 16: 147 (1905).**

H. culveri var. *integra* H. Bol. *ibid.*, syn. nov. Type: Barberton, *Culver* 84a (K; BOL!).

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KATHLEEN IMMELMAN

POACEAE

A NEW COMBINATION IN *ERIOCHLOA*

***Eriochloa meyerana* (Nees) Pilg. subsp. *grandiglumis* (Stent & Rattray) Gibbs Russell, comb. et stat. nov.**

Panicum meyeranum Nees, Fl. Afr. Austr. 32 (1841), as *meyerianum*. — var. *grandiglume* Stent & Rattray in Proc. Trans. Rhod. scient. Ass. 32: 28 (1933), as *grandeglume*.

Eriochloa meyerana (Nees) Pilg. in Natürl PflFam. ed. 2, 143: 56 (1940), as *meyeriana*.

In 1841 Nees described *Panicum meyeranum* which Pilger transferred to *Eriochloa* in 1940. I am in agreement with this decision, which is also supported by Clayton [Kew Bull. 30, 1: 107 (1975)], since the species is obviously more closely allied to *Eriochloa* than to *Panicum*, in spite of the presence of a lower glume, a character not occurring in any other *Eriochloa*.

In *Eriochloa* there is a bead-like swelling at the base of the spikelet which is the result of the fusion of the lower glume and the lowest rhachilla internode. In *Eriochloa meyerana* the glume projects above this bead as a truncate, inward-turned cuff surrounding the base of the spikelet. However, specimens from Zimbabwe, the Soutpansberg and the Kruger National Park in the Transvaal and from Zululand, have an ovate flat lower glume surmounting the bead that may be $\frac{1}{3}$ to $\frac{1}{2}$ the length of the spikelet. These specimens are readily recognized, are confined to a discrete region within the range of the species and constitute a taxon which in our opinion merits subspecific rank. This taxon was described as var. *grandiglume* by Stent and Rattray from Zimbabwe in

1933. Clayton (1975) cites this variety in synonymy under *Eriochloa meyerana*. A new combination raising this taxon to subspecific rank is made here.

Clayton (1975) states that the spikelet and inflorescence of *E. meyerana* are intermediate between *Eriochloa* and *Brachiaria mutica* (Forssk.) Stapf and postulates that *E. meyerana* and related elements may be the result of hybridization between *B. mutica* and different local species of *Eriochloa*. However, *B. mutica* is a tropical species which does not occur naturally in southern Africa. Typical *E. meyerana* may have migrated southwards after it originated in the tropical regions. The subspecies *grandiglumis* probably originated further south and if this taxon is also of hybrid origin one should look for the other parent in this area. No obvious parental species, however, presents itself. Because the subspecies *grandiglumis* is consistently more robust than the typical subspecies, it may be that it is simply a polyploid of *E. meyerana* subsp. *meyerana*. Cytological investigation may throw more light on this possibility.

Selected specimens:

TRANSVAAL.—2231 (Pafuri); Soutpansberg (—CA), Codd 5421 (PRE). 2331 (Komatiport); Kruger National Park (—DD), Coetzee 7028 (PRE).

NATAL.—2632 (Bela Vista); Maputaland (—DD), Maputaland Expedition s.n. (PRE). 2831 (Nkandla); Hlabisa, Zululand (—BB), Ward 2100 (PRE).

G. E. GIBBS RUSSELL

NOTES ON *DIGITARIA* IN SOUTH AFRICA

Since Henrard's monograph (1950) on *Digitaria* only Chippindall (1955) has contributed to the taxonomy of the genus in South Africa. Chippindall's contribution, however, was limited to comments and suggestions regarding the taxonomy and nomenclature, but few definite decisions were made. Although Henrard's monograph is a taxonomic milestone and will have to be considered in any subsequent work on the genus, some authors have criticized various aspects of the monograph, especially the unsatisfactory delimitation of species and infraspecific taxa. In southern Africa it is mainly taxa of the section *Erianthae*, that prove difficult to delimit. Most authors agree that too many taxa are recognized and that some of the presently accepted species might more correctly be assigned to taxa of lower rank.

A recent taxonomic investigation of the South African species of the genus by the present author (1978) has confirmed this view. Thus, in the enumeration that follows, several taxa recognized by Henrard are reduced to synonymy, one species is reduced to subspecific rank and transferred to another species, while one new subspecies is described.

1. ***Digitaria monodactyla* (Nees) Stapf** in Fl. Cap. 7: 373 (1898).

D. monodactyla (Nees) Stapf var. *explicata* Stapf in Fl. Trop. Afr. 9: 442 (1919).

2. ***Digitaria diversinervis* (Nees) Stapf** in Fl. Cap. 7: 379 (1898).

D. diversinervis (Nees) Stapf var. *woodiana* Henr. in Mon. Dig. 200 (1950).

3. ***Digitaria natalensis* Stent** in Bothalia 3: 152 (1930).

D. natalensis Stent subsp. *stentiana* Henr. in Blumea 1: 93 (1934).

D. natalensis Stent subsp. *stentiana* Henr. var. *paludicola* Henr. in Mon. Dig. 483 (1950).

D. macroglossa Henr. in Mon. Dig. 404 (1950).

D. macroglossa Henr. var. *prostrata* (Stent) Henr. in Mon. Dig. 406 (1950).

D. rigida Stent in Bothalia 3: 151 (1930).

4. ***Digitaria seriata* Stapf** in Fl. Trop. Afr. 9: 432 (1919).

D. polevansii Stent in Bothalia 3: 149 (1950).

5. ***Digitaria setivalva* Stent** in Bothalia 1: 268 (1924).

D. valida Stent subsp. *burchelliana* Henr. in Mon. Dig. 975 (1950).

D. pentzii Stent subsp. *dregeana* Henr. in Mon. Dig. 976 (1950).

6. ***Digitaria eriantha* Steud.** in Flora 12: 448 (1829).

6.1 subsp. ***eriantha***

D. smutsii Stent in Bothalia 1: 268 (1924).

D. geniculata Stent in Bothalia 3: 154 (1930).

D. stentiana Henr. in Blumea 1: 97 (1934).

D. bechuanica (Stent) Henr. in Mon. Dig. 295 (1950).

D. hiascens Mez in Bot. Jb. 57: 193 (1921).

6.2 subsp. ***pentzii* (Stent) Kok, comb. et stat. nov.**

D. pentzii Stent in Bothalia 3: 147 (1930).

D. valida Stent in Bothalia 3: 148 (1930).

D. valida Stent var. *glauca* Stent in Bothalia 3: 149 (1930).

D. decumbens Stent in Bothalia 3: 150 (1930).

6.3 subsp. ***stolonifera* (Stapf) Kok, stat. nov.**

D. pentzii Stent var. *stolonifera* (Stapf) Henr. in Mon. Dig. 544 (1950).

6.4 subsp. ***transvaalensis* Kok, subsp. nov.**

A typo subspecies longitudine spicularum differt.

Spiculae 2,2 — 2,6 mm longae.

TYPE.—Transvaal, 2527 (Rustenburg); Silkaatsnek, 1974-01-17, Kok 577 (PRE, holo.; PRU).

P. D. F. KOK

POLYGALACEAE

A CONSPICUOUS NEW SPECIES OF *MURALTIA*

Recently, while working at Kew, I found *Esterhuysen* 24754 among the South African material of *Polygala*. It certainly looked like a *Polygala* but, after careful study, I concluded that it belonged rather to the genus *Muraltia*, which is confined to South Africa, with the exception of *M. flanaganii* which extends northwards to Tanzania. After consulting Levyns's (1954) excellent monograph, it became clear that the specimen represented a new species.

Muraltia is closely allied to *Polygala* L., but differs in having an ericoid habit (rare in *Polygala*); flowers solitary and axillary (in terminal or lateral racemes, rarely solitary in *Polygala*); the carina is differentiated into claw and limb, with a cushion-like swelling (this differentiation is absent in *Polygala*), a 2-lobed expanded, leaf-like crest (fimbriate or plurilobed, rarely absent in *Polygala*); 7 stamens (*Polygala* has 8 stamens, rarely 9, 4 or 5, sometimes only 6 fertile with 2 staminodes); the filaments are united almost to the base of the anthers (in *Polygala* they are usually free for a considerable distance); and lastly, in *Muraltia* the anthers dehisce through a longitudinal slit (in *Polygala* dehiscence takes place through a large oblique pore). The pollen morphology (zonocolporate) is similar to that of *Polygala*, but more homogeneous.

Turczaninow (1855) divided *Muraltia* into two sections, which were considered as subgenera by Harvey (1860) and Levyns (1954). After an extensive study of herbarium material of *Polygala* (all African species and representatives of every main division of the genus), I cannot accept the division of *Muraltia* into two subgenera. The genus is morphologically much more homogeneous than *Polygala* and its pollen grain is always zonocolporate and isopolar in contrast to *Polygala*, which has isopolar and heteropolar pollen. If one accepts the two divisions of *Muraltia* as subgenera, one would have to divide *Polygala*, not into subgenera, but into separate genera, which is unacceptable. *Polygala* is a world-wide, very heterogeneous, genus, but a good one and it is doubtful whether anyone would suggest or accept the splitting of *Polygala* into separate genera. There are no valid geographical or distributional grounds for accepting that *Muraltia* should be divided into two subgenera. Therefore, *Muraltia* must be regarded as having two sections, namely sect. *Muraltia* and sect. *Psiloclada* Turcz in Bull. Soc. Imp. Nat. Moscou 27, 4: 353 (1855). These two sections may be easily distinguished by applying Levyns's subgeneric key:

Leaves usually fascicled, sometimes solitary; flowers sessile or with short pedicels; inner sepals usually slightly longer than the outer; crest attached in various ways; capsule never cernuous, often with long horn-like processes at the apex, occasionally without horns sect. *Muraltia*
 Leaves solitary; flowers with distinct, often long pedicels; inner sepals much longer than the outer; attachment of the crest long, almost vertical; capsule often cernuous, with or without 4 short horn-like processes at the apex, the horns never long and slender sect. *Psiloclada*

Section *Psiloclada* appears to be transitional between *Muraltia* sect. *Muraltia* and *Polygala* in the following characters: in having the two inner sepals coloured and sometimes almost wing-like, much longer than the outer ones, and a usually hornless capsule indistinguishable from that of *Polygala*. The new species, *M. elsieae*, which belongs to sect. *Psiloclada*, has the largest wings (inner sepals) in the genus, resembling a *Polygala*, hence the initial identi-

fication of the plant as a *Polygala*. In spite of this superficial resemblance in flower and in fruit (capsule hornless and broadly winged), it is nevertheless a true *Muraltia* (ericoid habit, solitary flowers; carina with distinct claw and limb, a cushion-like swelling, and an expanded leaf-like crest; stamens 7).

The new species, *M. elsieae*, is named after Miss Elsie Esterhuysen of the Bolus Herbarium, whose collections in South Africa have made a valuable contribution to the knowledge of the flora of that country. It can easily be distinguished from the other species in the section by adapting the first dichotomy in Levyns's key to subgen. *Psiloclada*. On the characters, 'Inner sepals about twice as long as the outer, concealing the carina, leaves rough; capsule without apical horns or teeth', she keys out only *M. polyphylla* (DC.) Levyns. The key can be amended as follows:

1. Inner sepals at least twice as long as the outer, concealing the carina; capsule without apical horns or teeth:
 Flowers 4–5 mm long, inner sepals about twice as long as the outer; leaves scabrous, 5–10 mm long ... 9. *M. polyphylla*
 Flowers 11–13.5 mm long, inner sepals more than twice as long as the outer; leaves not scabrous, 15–25 mm long 9a *M. elsieae*
1. Inner sepals much less than twice as long as the outer, not concealing the tip of the carina; capsule with apical horns or teeth: Remaining species

Muraltia elsieae J. Paiva, sp. nov.

Frutex ramosus circa 1,5 m altus; rami teretes glabri. *Folia* alterna petiolata, petiolo 0,5 mm longo glabro; lamina 15–25 × 1–1,5 mm, lanceolato-linearis, apice subacuta, breviter mucronata, glabra. *Flores* purpurei, solitarii pedicello 2–3 mm longo glabro; bractae bracteolaeque similes, 1–1,5 mm longae, cucullatae, ovatae, ciliatae, obtusae. *Sepala* inaequalia; sepalum posterius, 2,5 × 1,5 mm, ovatum, apice nonnihil apiculatum, ciliatum; alae 11–13,5 × 4,5 mm, ovato-ellipticae, apice obtusae, basim versus ciliatae; sepala anteriora libra 2 × 1,5 mm, ovata, apice nonnihil apiculata, ciliata. *Petala superiora* 6–7 × 1 mm, oblonga, sed ad basim majora obtusa, quam carina paulo longiora; carina 3,5 × 1,5–1,8 mm, ungue limbum aequanti; crista ampla 1 mm longa, lobis superioribus et inferioribus similibus. *Ovarium* 1 × 0,75 mm, applanato-ellipsoideum, apice bilobatum glabrum; stylus gracilis, 1,5 longus, teres, lobo posteriore stigmatico bene evoluto longiore, anteriore brevior truncato glabro. *Capsule* 6–7 × 5,5–6 mm, applanato-ellipsoidea, apice bilobata, glabra, margine alata, 1,3–1,8 mm lata. *Semina* 5 × 1,5 mm, ellipsoidea, sparse albobubrescentia, carunculata; caruncula 1,5 mm longa, pubescens, appendicibus brevibus membranaceis.

TYPE.—Cape, 3321 (Ladismith): Seven Weeks Poort, rocky slopes, 990–1 320 m, fl. & fr. 1955-10-13, *Esterhuysen* 24754 (BOL.; K, holotypus).

Slender single-stemmed shrub c. 1,5 m tall, branching above, branches cylindric, glabrous. *Leaves* alternate, very shortly petiolate (petiole 0,5 mm long, glabrous), 15–25 × 1–1,5 mm, lanceolate-linear, subacute and shortly mucronate at the apex, glabrous. *Flowers* pale purple, solitary; pedicels 2–3 mm long, glabrous, bracts and bracteoles similar, 1–1,5 mm long, obtuse, cucullate ovate, ciliate. *Sepals* unequal; posterior 2,5 × 1,5 mm, ovate-elliptic somewhat apiculata at the apex, ciliate; wing-sepals

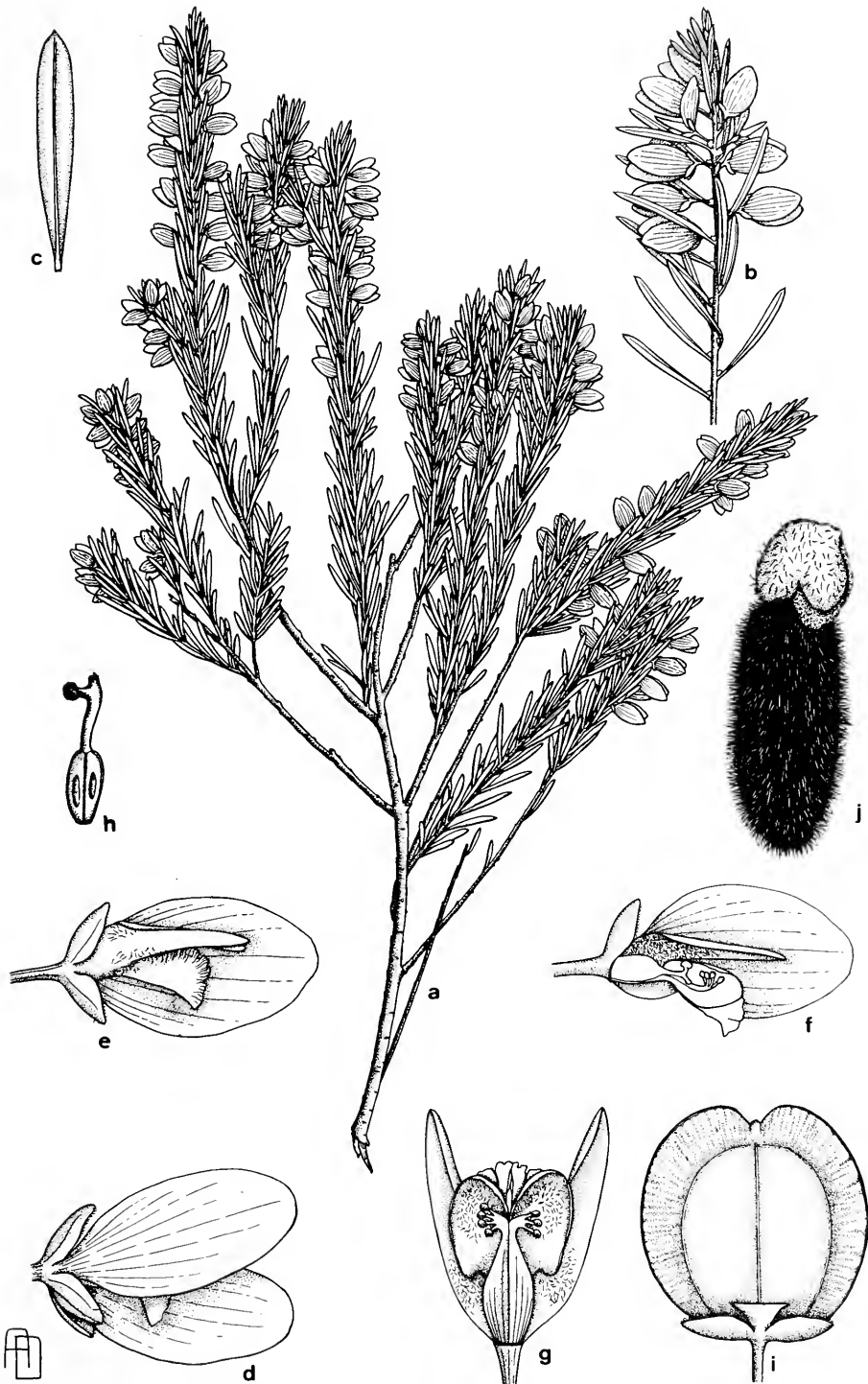


FIG. 28.—*Muraltia elsiae*. a, habit ($\times 0,7$); b, small section of branch ($\times 1,3$); c, leaf ($\times 2,7$); d, flower ($\times 5,3$); e, flower with one wing removed ($\times 5,3$); f, vertical section of flower ($\times 5,3$); g, flower without sepals and ovary ($\times 6,7$); h, ovary, style and stigma ($\times 6,7$); i, capsule ($\times 5,3$); j, seed ($\times 13,3$). All from Esterhuysen 24754.

11–13, 5 × 4–5 mm, ovate-elliptic, obtuse at the apex, ciliate towards the base; anterior sepals free, 2 × 1,5 mm, ovate, somewhat apiculate at the apex, ciliate. *Petals*, the upper 6–7 × 1 mm, oblong but enlarged towards the base, obtuse, sparsely pubescent towards the base outside, and pubescent inside, somewhat apiculate, slightly longer than the carina; carina 3,5–4 × 1,5–1,8 mm, with the claw as long as the limb; crest 1 mm long with superior and inferior lobes similar. *Ovary* broadly ellipsoid, 1 × 0,75 mm, glabrous, shortly bilobed at the apex; style 1,5 mm long, terete, the anterior branch bruncate, glabrous, the posterior stigmatic branch well-developed. *Capsule* 6–7 × 5,5–6 mm, broadly ellipsoid to subcompressed globose, bilobed at apex, glabrous, margin winged (wing 1,3–1,8 mm wide). *Seed* 5 × 1,5 mm, ellipsoid, sparsely white pubescent; caruncle 1,5 mm long, pubescent and with very short appendage. Fig. 28.

CAPE.—3321 (Ladismith): Seven Weeks Poort, Esterhuysen 24754 (BOL; K, holotypus); Marloth 2946 (BOL).

REFERENCES

- HARVEY, W. H., 1860. Polygalaeae. In W. H. Harvey & O. Sonder, *Fl. Cap.* 1: 79–113.
 LEVYNS, M. R., 1949. The floral morphology of some South African members of Polygalaceae. *Jl S. Afr. Bot.* 15: 79–92.
 LEVYNS, M. R., 1952. Clues to the past in the Cape Flora of to-day. *S. Afr. J. Sci.* 49, 3–4: 155–164.
 LEVYNS, M. R., 1954. The genus *Muraltia*. *Jl S. Afr. Bot.*, Suppl. 2, 247 pp.
 LEVYNS, M. R., 1955. Some geographical features of the family Polygalaceae in Southern Africa. *Trans. r. Soc. S. Afr.* 34, 3: 379–386.
 TURCZANINOW, N., 1855. Animadversiones ad primam partem herbarii Turczaninowiani, nunc Universitatis Caesareae Charkoviensis. *Bull. Soc. Imp. Nat. Moscou* 27, 4: 271 (bis)—372.

J. A. R. PAIVA*

VITACEAE

A NEW SPECIES OF *CYPHSTEMMA* FROM THE TRANSVAAL

Cyphostemma hardyi Retief, sp. nov., *C. bainesii* (Hook. f.) Desc. affinis, a qua fructu glanduloso pubescentia differt.

Planta succulenta, radici tuberosa, usque 0,5 m alta. *Caulis* cylindraceus, aliquando ramosus, ramulis junioribus tectis trichomatibus longis, albis, multicellulosis, eglandulosis; cortice brunneo. *Folia* spiraliter disposita, simplices vel 3(5) foliolata, sessilia vel petiolata, pubescentia; lamina obovata, 130–320 × 8–20 mm, margine dentata rubella, apice obtusato vel truncato; stipulis praesentibus. *Inflorescentia* cymosa foliis opposita; pedunculis cum pedicellis trichomatibus multis multicellulosis stipitatis glandulosisque. *Flores* tetrameri, bisexuals. *Calyx* cupulatus, integer. *Corolla* flavo-virens; petalis 2 mm longis, cucullatis, caducis. *Stamina* filamentis dorsifixis. *Ovarium* biloculare, disco et glandibus quattuor cingente, ommibus ovario adnatis. *Stylus* persistens, stigmatibus bilobato. *Fructus* bacca globulosa, 11–15 mm longus, pubescens glandulosus, ruber vividus. *Semina* cristata.

TYPE.—Transvaal, 2427 (Thabazimbi): wooded koppies on the farm Malmanieshoek, Waterberg District (—BA), *Hardy 1256* (PRE, holo.; K; MO).

Succulent up to 0,5 m in height with a tuberous rootstock. *Stem* cylindric, sometimes branched, younger covered with long, whitish multicellular, non-glandular trichomes and stalked, glandular trichomes; bark brown, peeling off in pale brown strips. *Leaves* spirally arranged, simple or 3(5)-foliolate, base of terminal leaflet symmetrical, bases of lateral leaflets asymmetrical, main leaf sessile or petiolate but leaflets sessile, petioles 60–90 mm long if present, greyish green, densely covered with white, multicellular trichomes lying more or less in the same direction, trichomes tubular or cells of the trichome twisted, all laminae obovate, 130–320 mm long and 8–20 mm broad, margin toothed, reddish, apex rounded or truncate; stipules lanceolate, ± 15–20 mm long, densely hairy, sometimes denticulate, teeth and apex sometimes gland-tipped. *Inflorescence* a leaf-opposed corymbose cyme; peduncles and pedicels with numerous, multicellular, stipitate glandular trichomes, 0,7–1 mm long. *Flowers* tetramerous, bisexual. *Calyx* 0,5–0,7 mm in height entire,

cupshaped. *Corolla* 4-partite, yellowish green tinged with maroon; petals ± 2 mm long, hooded at the apex, becoming reflexed, caducous. *Stamens* 4; filaments dorsifixes; anthers 0,5–0,7 mm long. *Ovary* bilocular, surrounded by a disk and four glands alternating with the petals and stamens, all adnate to the ovary. *Style* 0,8–1 mm, persistent, ter-



FIG. 29.—*Cyphostemma hardyi*. Hardy 1256, holotype in PRE.

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FIG. 30.—*Cyphostemma hardyi*. Painting of part of holotype plant by Cythna Letty.

minating in a slightly bilobed stigma. *Fruit* a globose to ovoid bright red berry, 11–15 mm long and 12,5–14 mm broad, glandular pubescent, glands 1–1,3 mm long, stalked, multicellular with globose heads. *Seed* 8–10 mm, crested, embedded in a firm bright yellow mass. Figs 29 & 30.

TRANSVAAL.—2427 (Thabazimbi): wooded koppies on the farm Malmanieshoek, Waterberg District (—BA); *Hardy* 1256 (K; MO; PRE); amongst boulders of Waterberg conglomerate, farm Malmaniesriver, Waterberg District (—BA), *Hardy, Retief & Herman* 5287 (PRE); south-western slopes of the Kransberg (—BC), *Dyer & Verdoorn* 4230 (PRE).

C. hardyi is endemic to the Transvaal, where it is known only from a restricted area in the western part of the Waterberg mountain range. It occurs on slopes amongst boulders of Waterberg-conglomerates in the shelter of trees such as *Albizia tanganyicensis* Bak. f. subsp. *tanganyicensis*, which also has a conspicuous papery bark. Other succulents like *Huernia quinta* (Phill.) White & Sloane, *Aloe chabaudii* Schoenl., *A. marlothii* Berger, *A. transvaalensis* Kuntze and *A. aculeata* Pole Evans are found growing in the same area.

The peculiar growth form of *Cyphostemma hardyi* distinguishes it from all the other known species of the genus in the Transvaal which are herbaceous or succulent, prostrate or erect creepers. The stems of *C. hardyi* are sometimes very short, because the plants are often subjected to veld fires causing them to die back. The leaves fall off during the winter resting period and leave prominent leaf scars.

C. hardyi has an extraordinary distribution. The species of the genus *Cyphostemma* that show the closest affinities with *C. hardyi* occur in South West Africa and in no other part of southern Africa. *C. hardyi*, *C. bainesii* (Hook. f.) Desc. and *C. uter* (Exell & Mendonça) Desc. are all stem-succulents having caudices more or less 0,3–0,8 m high whereas *C. jutae* (Dinter & Gilg) Desc. and *C. currorii* (Hook. f.) Desc. [= *C. cramerianus* (Schinz) Desc.] are succulent trees 4–7 m in height. Although the leaves of *C. bainesii* resemble those of *C. hardyi*, the leaf margin is shallowly toothed in the case of *C. bainesii*, and the leaves of *C. hardyi* are much more densely covered with the long thin multicellular hairs, present on both species. *C. uter* has leaves with a conspicuous wavy margin and multicellular, glandular hairs similar to those on the fruits of *C. hardyi*, as well as multicellular non-glandular hairs with peculiar outgrowths.

The first record of *C. hardyi* in the National Herbarium was from a steep south-western slope of the Kransberg where Dr R. A. Dyer and Dr Inez Verdoorn collected material of the species during January 1942. The species has been named after Mr D. Hardy, who is a well known horticulturist on the staff of the Botanical Research Institute.

E. RETIEF

The phytogeography and ecology of *Macrocoma* (Orthotrichaceae, Musci) in Africa

ROBERT E. MAGILL* and DALE H. VITT**

ABSTRACT

Of the 11 species presently recognized in the genus *Macrocoma* (Orthotrichaceae, Musci), four occur in Africa. These species are xeromorphic and occur in savannas, woodlands, and forests, roughly corresponding to the Afromontane Phytogeographic Region. *Macrocoma tenue* (Hook. & Grev.) Vitt subsp. *tenue* is widespread in southern Africa, north to Ethiopia and also occurs in Australasia. Three species are endemic, with *M. pulchella* (Hornsch.) Vitt found only in the Cape area; *M. abyssinica* (C. Müll.) Vitt occurring in eastern Africa, and *M. lycopodioides* (Schwaegr.) Vitt distributed sporadically in eastern and southern South Africa.

RÉSUMÉ

LA PHYTOGÉOGRAPHIE ET L'ÉCOLOGIE DU MACROCOMA (ORTHOTRICHACEAE, MUSCI) EN AFRIQUE

Des 11 espèces actuellement reconnues dans le genre *Macrocoma* (Orthotrichaceae, Musci) quatre se trouvent en Afrique. Ces espèces sont xeromorphiques et surviennent dans les savanes, les terrains boisés et les forêts correspondant grosso-modo à la Région Phytogéographique Afromontane. *Macrocoma tenue* (Hook. & Grev.) Vitt sous-esp. *tenue* est répandue en Afrique australe, le nord le l'Éthiopie et survient aussi en Australasie. Trois espèces sont endémiques, avec *M. pulchella* (Hornsch.) Vitt survenant seulement dans la région du Cap; *M. abyssinica* (C. Müll.) Vitt survenant en Afrique orientale et *M. lycopodioides* (Schwaegr.) Vitt distribuée sporadiquement dans l'Est et dans le Sud de l'Afrique du Sud.

The moss genus *Macrocoma* (Hornsch. ex C. Müll.) Grout is a member of the family Orthotrichaceae, subfamily Macromitrioideae. Within this subfamily there are about eight genera, of which *Macromitrium* with approximately 250 species is the largest. *Macrocoma* was first recognized as a section by C. Müller in 1845, and later Brotherus (1901–1909) considered it a subgenus of *Macromitrium*. Grout (1944) was the first author to recognize this taxon at the generic level, and most authors have accepted it since that time as a distinct genus.

Briefly, the genus can be characterized by creeping, slender stems and branches with imbricate, closely set leaves, and by the uniformly rounded to elliptic leaf cells. The basal cells, particularly at the margins are more or less similar in shape to the upper ones. The calyptrae are large, plicate and cover the entire capsule. From *Macromitrium* and *Groutiella*, the macroscopic appearance of species of *Macrocoma* is quite different since in the former two genera, the leaves are always twisted, contorted, or incurved giving the individual plants a 'bushy' appearance. Keys to all species are presented in Vitt (1980a) and the taxonomy and nomenclature are discussed by Vitt (1973, 1980a, 1980b). Presently eleven species, one with two subspecies, can be recognized in the genus. Within the subgenus *Trachyphylum* (Broth.) Vitt there are two species [*M. gracillima* (Besch.) Vitt and *M. papillosa* (Thér. in Herz.) Vitt], both restricted in distribution to southern South America. The subgenus *Macrocoma* is widespread in both Southern and Northern Hemispheres, with two species widespread in distribution. *Macrocoma orthotrichoides* (Raddi) Wijk & Marg. and *M. tenue* (Hook. & Grev.) Vitt occur in both the Old and New World (Fig. 1), *M. frigida* (C. Müll.) Vitt, *M.*

gastonyi Vitt, and *M. brasiliensis* (Mitt.) Vitt are endemic to South and Central America (+ Mexico), whereas *M. iwatsukii* Vitt has been collected only in the Himalayan Mountains.

Three species occur only in southern and eastern Africa, (Fig. 1) and, along with *M. tenue* subsp. *tenue* comprise the African members of this genus. These species occur on the branches and trunks of angiospermous or rarely coniferous trees and occasionally on rocks and boulders. Sim (1926) stated that species of the *M. tenue* complex 'are common and are present in every bush and on nearly every soft moist stone in South Africa'. The African species of *Macrocoma* are xeromorphic and occur in savannas, woodlands and forests, roughly corresponding to the Afromontane Phytogeographic Region (cf. Werger, 1978). The species are frequently encountered along the afromontane 'archipelago' that extends from coastal areas of the Cape Province, northward along the mountainous regions of eastern Africa, to Ethiopia. This part of the Afromontane Region is mostly surrounded by the Zambezi Domain of the Sudano-Zambezian Phytogeographic Region, where typical vegetation types are dry woodlands, savannas or grasslands. The absence of *Macrocoma* from lowland rainforests, typical of the Guinea-Congolian Phytogeographic Region of central and western Africa, probably explains the conspicuous absence of the species from west African outliers of the Afromontane vegetation in the Cameroon and Guinea-Ivory Coast areas.

Ecologically the species are highly adapted to such habitats with high light intensities and low annual precipitation as the African savannas and woodlands. Specimens are, however, frequently collected in dense, moist, montane or kloof forests, indicating a rather wide acceptance of habitats throughout the Afromontane Region.

The maps illustrating the distributions of African species of *Macrocoma* (Figs 2–5) were computer

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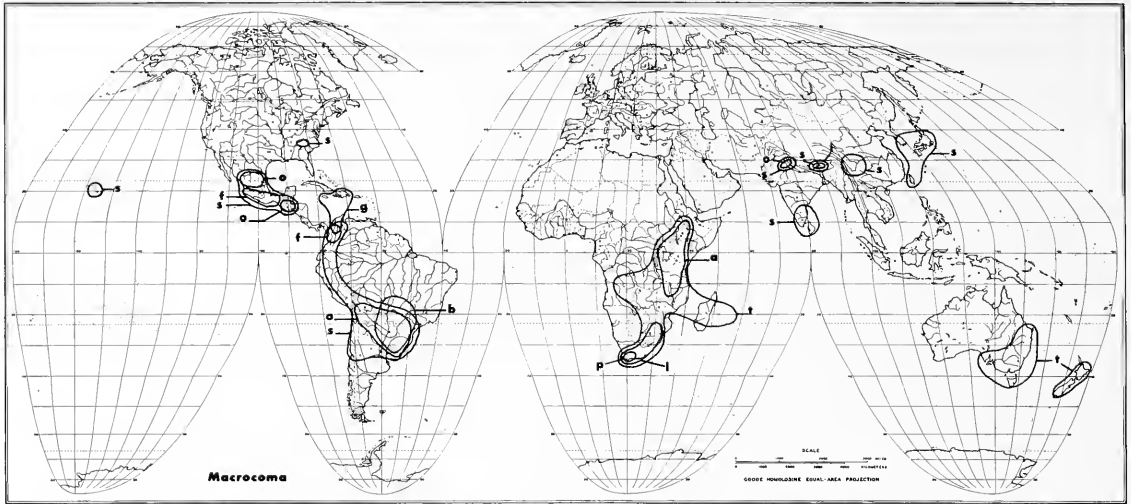


FIG. 1.—Approximate world distribution of the nine species in *Macrocoma* subgenus *Macrocoma*. Northern South American patterns are not well known and here hypothetical as are the western Australian and Chinese distributional limits. The Indian populations are probably more widespread than indicated. Data taken only from specimens examined (see Vitt, 1980a for herbaria consulted). Abbreviations: a = *abyssinica*, b = *brasiliensis*, f = *frigida*, g = *gastonyi*, i = *iwatsukii*, l = *lycopodioides*, o = *orthotrichoides*, p = *pulchella*, s = *tenue* subsp. *sullivantii*, and t = *tenue* subsp. *tenue*.

plotted. In connection with research on the Flora of Southern Africa, the Data Section of the Botanical Research Institute, has written programs that plot distributions for taxa in southern Africa (Figs 3, 5, & 6) or part of Africa and Madagascar as seen in Figs 2 & 4. Distributional data are entered for each taxon using the Quarter-Degree Square Reference System (Edwards & Leistner, 1971; Edwards, 1981). The mapping program compares entries in the distribution data file of the taxon to be mapped and plots a quarter-degree square only once. Therefore, a dot on the map indicates presence of the taxon in the quarter-degree square and may represent single or multiple entries in the data file.

(1) *Macrocoma abyssinica* (C. Müll.) Vitt — Ethiopia, Kenya, Malawi, Rwanda, Tanzania, Uganda, Zaire. This species is most closely related to *M. tenue* and appears to be endemic to the Afromontane flora of eastern Africa. Restricted in distribution, *M. abyssinica* is most frequently collected in the Usambara and Ruwenzori Mountain areas. A few collections have come from the Uluguru-Mlanje Mountains to the south and the type represents the only collection seen from the Ethiopian Mountain system to the north (Fig. 2).

(2) *Macrocoma tenue* (Hook. & Grev.) Vitt subsp. *tenue* — Angola, Ethiopia, Kenya, Réunion, Lesotho, Madagascas, Malawi, Rwanda, South Africa, Swaziland, Tanzania, Transkei, Zaire, Zambia, Zimbabwe. Also known from eastern Australia and New Zealand. The most widely distributed of the African species, *M. tenue* is often collected on trees and occasionally on rocks and boulders. The species is frequently encountered in Afromontane forest remnants within the Fynbos Biome of the southern and south-western Cape Province. Extending to the northeast, it becomes more common in the high forests and grasslands of the Drakensberg and escarpment of the eastern Transvaal (Fig. 3). The species has been collected only occasionally in the Chimanimani Mountains of Zimbabwe and the Uluguru-Mlanje Mountains of Malawi and Tanzania,

but occurs frequently in the Ruwenzori and Usambara Mountains of eastern Africa. Only a single specimen is presently known from the mountains of southern Ethiopia, marking the northernmost extension of its range.

Outside its major north-south distribution axis, *M. tenue* is found in the montane vegetation of Madagascar and Réunion, and in isolated western outliers

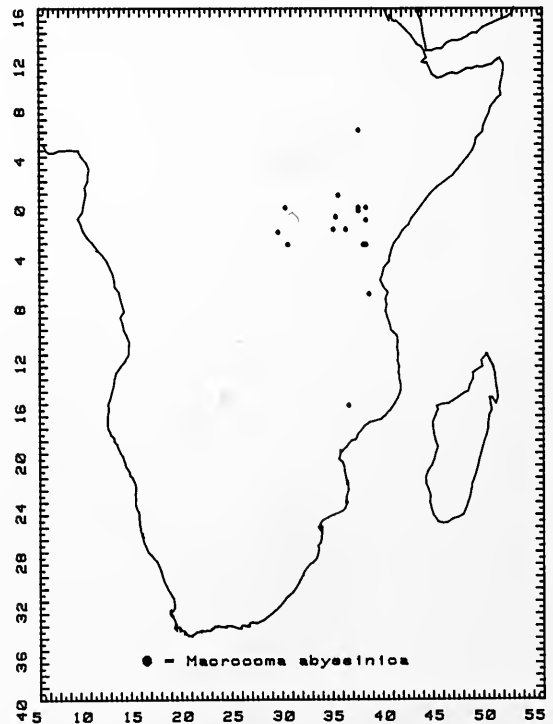


FIG. 2.—African distribution of the endemic *Macrocoma abyssinica*.

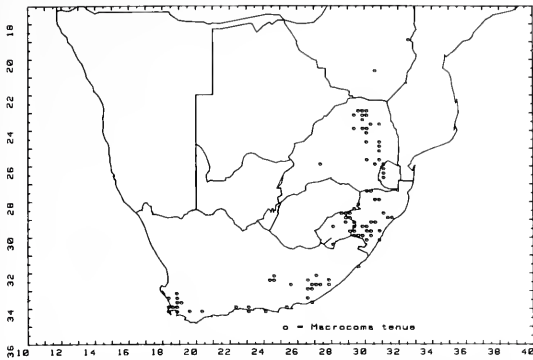


FIG. 3.—Southern African distribution of *Macrocoma tenue* subsp. *tenue*.

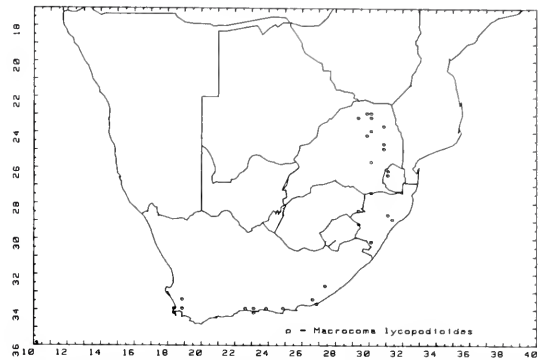


FIG. 5.—African distribution of the endemic *Macrocoma lycopodioides*.

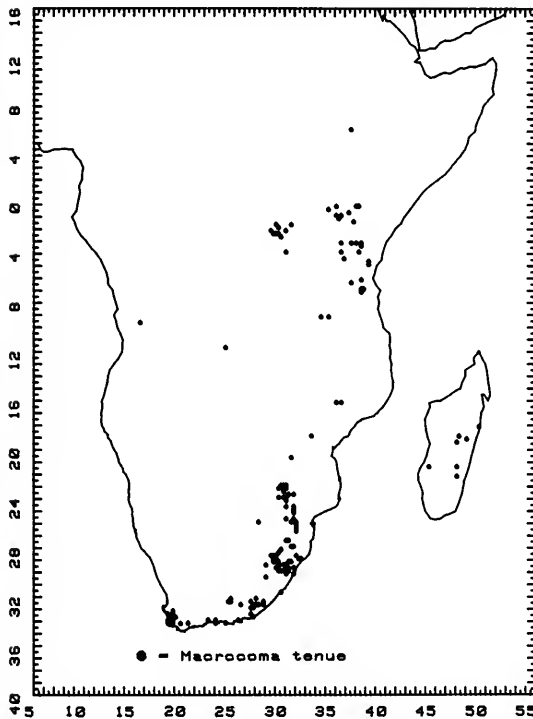


FIG. 4.—African distribution of *Macrocoma tenue* subsp. *tenue*.

of the Afromontane vegetation and surrounding Zambezan woodlands of central Zaire and Angola (Fig. 4).

(3) *Macrocoma lycopodioides* (Schwaegr.) Vitt — South Africa, Swaziland, Transkei. Presently known only from eastern and southern parts of southern Africa, *M. lycopodioides* is less common than *M. tenue*. The two species are practically sympatric in southern Africa and are often intermixed. *Macrocoma lycopodioides* is easily differentiated from its closest relative, *M. tenue*, by having fragile leaf apices. Specimens of *M. lycopodioides* are occasionally collected in relic montane forest within the Fynbos Biome of the southern and south-western Cape, as well as forests and woodlands of the eastern Cape, Transkei and Natal. Extending northward into

the savannas or forests of the Orange Free State, Swaziland and the escarpment of the eastern Transvaal, the species reaches the northernmost part of its range in the woodlands of the Soutpansberg in the northern Transvaal (Fig. 5).

(4) *Macrocoma pulchella* (Hornsch.) Vitt — South Africa. Endemic to South Africa, this species is known from only a few collection sites in the south-western Cape Province. Very little is known about its distribution or ecology, but it also appears to be restricted to areas of relic montane forest within the Fynbos Biome. It is interesting that the areas where *M. pulchella* has been collected (Table Mountain, Devil's Peak and Jonkershoek) receive some of the highest precipitation in southern Africa. The species is probably most closely related to *M. tenue*, however, the fused, 2-layered, well-developed peristome and unique gametophytic features (see Vitt, 1980b) make this a very distinctive species (Fig. 6).

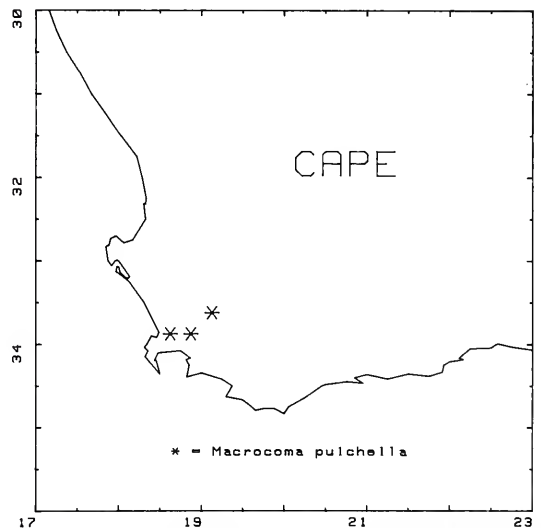


FIG. 6.—African distribution of the endemic *Macrocoma pulchella*.

ACKNOWLEDGEMENTS

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of this research. African distributions are mapped based on specimens in BOL, BM, BR, C, COLO, DUKE, EGR, H, L, MO, NAM, PRE, & Herb. Townsend (KEW), and we wish to thank the curators of these herbaria for loan of specimens. We also wish to thank the Data Section (BRI) and especially Dr H. F. Glen for access to the computer programs.

UITTREKSEL

Van die 11 spesies wat tans in die genus Macrocoma (Orthotrichaceae, Musci) erken word, kom vier in Afrika voor. Hierdie spesies is xeromorfies en word in savannas, bosse en woude aangetref, min of meer ooreenkomstig die Afromontane Plantgeografiese Stree. Macrocoma tenue (Hook. & Grev.) Vitt subsp. tenue is wydverspreid in suidelike Afrika, noordwaarts tot in Ethiopië, en word ook in Australasië aangetref. Drie spesies is endemies, waarvan M. pulchella (Hornsch.) Vitt slegs in die Kaapse gebied voorkom; M. abyssinnica (C. Müll.) Vitt in oostelike Afrika aangetref word, en M. lycopodioides

(Schwaegr.) Vitt sporadies versprei is in die ooste en suide van Suid-Afrika.

REFERENCES

- BROTHERUS, V. F., 1901–1909. Musci. In A. Engler & K. Prantl, *Die Natürlichen Pflanzenfamilien* 1(3, 1, 11): 277–1246. Leipzig: W. Engelmann.
- EDWARDS, D. & LEISTNER, O. A., 1971. A degree reference system for citing biological records in southern Africa. *Mitt. bot. Stsamml., Münch.* 10: 501–509.
- EDWARDS, D., 1981. A note on the extension of the Degree Reference System for citing biological distribution records to north of Equator and west of Greenwich meridian. *Bothalia* 13: 574–575.
- GROUT, A. J., 1944. Preliminary synopsis of the North American Macromitriaceae. *Bryologist* 47: 1–22.
- MÜLLER, C., 1845. Synopsis Macromitriorum hactenus cognitorum. *Bot. Ztg* 3: 521–526, 539–545.
- SIM, T. R., 1926. The bryophyta of South Africa. *Trans. R. Soc. S. Afr.* 15: 1–475.
- VITT, D. H., 1973. A revisionary study of the genus *Macrocoma*. *Revue bryol. lichen.* 39: 205–220.
- VITT, D. H., 1980a. The genus *Macrocoma* 1. Typification of names and taxonomy of the species. *Bryologist* 83: 405–435.
- VITT, D. H., 1980b. The nomenclature and taxonomy of *Macrocoma lycopodioides* (Schwaegr.) Vitt. *J. Bryol.* 11: 219–229.
- WERGER, M. J. A., 1978. Biogeographical division of southern Africa. In M. J. A. Werger, *Biogeography and ecology of southern Africa* 1: 147–170. The Hague: W. Junk.

Phytogeography and speciation in the vegetation of the eastern Cape

G. E. GIBBS RUSSELL* and E. R. ROBINSON**

ABSTRACT

The eastern Cape is a region of variable environmental factors, with a flora estimated at about 3 600–4 000 species and encompassing 21 of Acocks's (1975) veld types. It lies at the edges of the major phytochoria present in southern Africa, with many tropical species reaching the southern and western limits of their distribution, and many south-western Cape and Karoo species reaching the northern and eastern limits of their distribution. The apparently low incidence of species endemic to the eastern Cape may be the result of selection for 'generalist' genotypes and the close proximity of different phytochoria, which may allow species to migrate between phytochoria to fill niches resulting from environmental change.

RÉSUMÉ

PHYTOGÉOGRAPHIE ET SPÉCIATION DE LA VÉGÉTATION DU CAP ORIENTAL

Le Cap oriental est une région de milieux à facteurs variables, avec une flore estimée à environ 2 600–4 000 espèces et renfermant 21 des types champêtres Acocks (1975). Il repose aux bords de la phytochoria majeure présent en Afrique australe, avec beaucoup d'espèces tropicales atteignant les limites australes et occidentales de leur distribution, et beaucoup d'espèces du Cap sud-occidental et du Karoo atteignant les limites septentrionales et orientales de leur distribution. L'incidence apparemment faible d'espèces endémiques au Cap oriental peut être le résultat de sélection pour génotypes 'généraliste' et la proximité étroite de différents phytochoria, lesquels peuvent permettre aux espèces d'émigrer entre phytochoria pour remplir des niches résultant de changement de milieu.

INTRODUCTION

The eastern Cape, here defined as the area south of 32°S and between 24°E and the Great Kei River, has long been known as an area rich in species and communities and one of phytogeographical interest and complexity. To date, however, little systematic work has been done and the flora remains poorly understood. This paper presents data illustrating species and community diversity within the eastern Cape, and between it and other areas of southern Africa, and discusses some aspects of speciation in the eastern Cape flora.

DESCRIPTION OF THE AREA

The region covers an area of about 88 000 km², and is climatically and topographically very variable. Much of the range of climate and many landforms found elsewhere in southern Africa can be encountered in the eastern Cape.

The land rises from sea level in the south and south-east to about 2 100 m in the north-west and 1 500 m in the north-east (Fig. 1). There are two major mountain ranges, the Winterberg roughly in the centre of the area (with a maximum height of 2 360 m), and the coastal ranges north and west of Port Elizabeth, which are about 1 500 m high. The terrain is much dissected by numerous small and a few large rivers, so that there is little flat country, except in the west, and this naturally produces marked environmental heterogeneity over short distances.

Rainfall varies in amount and seasonality. As a general rule, amount decreases from the coast inland and from east to west (Fig. 1), with the highest precipitation being recorded from the southern slopes of the central mountain ranges. An appreciable proportion of the area is semi-arid. Furthermore, over much

of the area rainfall is unreliable and droughts are not uncommon. Of greater phytogeographical significance, is the seasonal pattern of rainfall. In the southern third of the eastern Cape, a considerable proportion of the rain falls in winter, whereas in the north-eastern part the rainfall has a summer pattern; therefore over much of this region there can be some rain at nearly any time of the year. Also, the line denoting equal probability of spring or autumn rainfall runs through the northern part of the area. Some places receiving summer rains have a bimodal distribution of rain, with peaks in late spring and autumn. A further aspect of rainfall distribution which adds to environmental heterogeneity is illustrated in Fig. 2. Here the month-by-month movement of the 50 mm rainfall isohyet is plotted for the summer rainfall region, and it can be seen that it converges on the area of Grahamstown, with the result that in the centre of the eastern Cape there is a concentration of seasonal rainfall changes into narrow bands. (Weather Bureau, 1965).

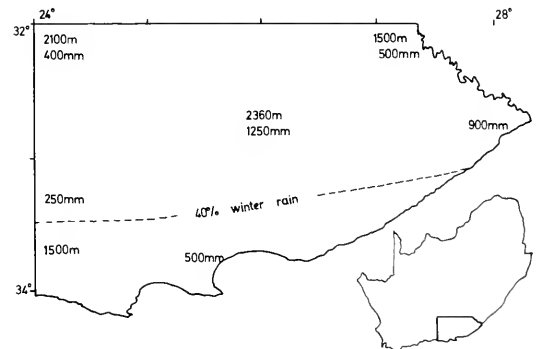


FIG. 1.—Generalized diagram of rainfall and altitude in the eastern Cape.

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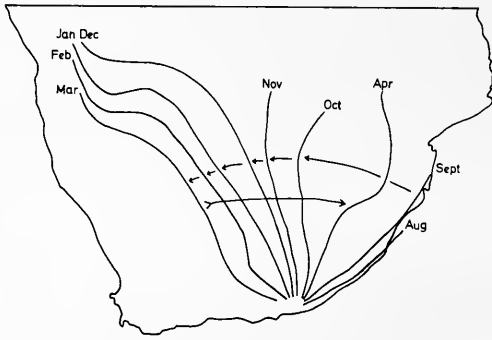


FIG. 2.—Seasonal movement of the 50 mm rainfall isohyet in the summer rainfall area, showing its convergence on the eastern Cape (Weather Bureau, 1965).

Temperatures also vary from the coast inland, with summer mean daily minima of 14–19°C and maxima of 25–32°C, and winter mean daily minima of 2–10°C and maxima of 16–21°C. The more extreme temperatures occur in the north and west of the area. Frost occurs in winter at higher altitudes, particularly at sites where temperature inversions occur. Snow has been recorded occasionally from a few localities at low altitude (e.g. Grahamstown in 1976) and is rather regular in mountainous parts of the area (Weather Bureau, 1965).

Geologically much of the eastern Cape is underlain by Karoo System rocks (Haughton, 1963). These consist mainly of shales and sandstones of the Beaufort and Ecca Series, with dolerite dykes and intrusions common to the whole Karoo System. Silcrete 'cappings' produce many of the highest hills. In addition, a number of outcrops of Witteberg Quartzite of the Cape System are found and their occurrence is biogeographically very important. Even small and isolated outcrops, such as that forming Mount Coke near King William's Town, support 'islands' of fynbos vegetation of the Cape Floral Kingdom deep within vegetation of tropical origin.

The soils derived from these rocks differ considerably. The most noticeable fine-scale variations attributable to the underlying rocks are those produced by the dolerite intrusions and the quartzites. Change from one soil type to another can be abrupt, and because the soil type can affect water availability there is considerable interaction between climatic and edaphic parameters, producing a wide range of habitats over short distances.

A further environmental factor which must be mentioned is the impact of man. Over the past 100 years or so European farming has changed the pattern of utilization of the vegetation and has introduced many alien species. There are records that by 1705 the Xhosa had settled on the banks of the Great Fish River and were in possession of large herds of cattle (Soga, 1931). Grazing and overgrazing by sheep, goats and cattle, and more recently the introduction of alien plants, must have had considerable influence on species composition and plant speciation in the area.

FLORISTICS, PHYTOGEOGRAPHY AND PHYTOSOCIOLOGY

Floristics and phytogeography

To date there is no complete flora for the area. A preliminary check list is in preparation, and extra-

potation from this list and Martin & Noel's (1960) Flora of Albany and Bathurst gives an estimated number of 3 600 to 4 000 vascular plant species. This estimate agrees reasonably well with the number of species in areas of similar size, such as Natal (Gibbs Russell, 1975; Oliver, 1977). Floristic information for the present paper has been obtained from monographs and other works dealing with various groups, and data collected by the authors in the course of other studies.

The eastern Cape has long been known to botanists as an area where major vegetation units meet in southern Africa. Here the Indian Ocean Coastal Belt, Zambezi Domain, Afromontane, Karoo-Namib and Capensis phytochoria of the sub-continent are adjacent to one another (Werger, 1978; Goldblatt, 1978; U.N.E.S.C.O./A.E.T.F.A.T., 1980). At many sites the mixing is so intimate that species of different phytochoria intermingle in a single stand of vegetation. Detailed examination of distributions of taxa show clearly that the elements composing the eastern Cape flora have their centres elsewhere (Tables 1–3). The distribution of both grasses and trees (Table 1) reflects their tropical origin. The majority reach their south-western limits in the eastern Cape and range to the north and east. A minority of species are of southern derivation and extend no further north than our area. Nearly all the species that extend in both directions from the eastern Cape are those with extremely wide ranges in southern Africa. Taxa characteristic of the south-western Cape (Table 2) and the Karoo (Table 3) also show a drop in numbers of species across our area, with many taxa that come as far as the eastern Cape but go no further to the north or east. In general then, the tropical elements of the southern African flora extend no further to the south and west than the eastern Cape, and the south-western Cape and Karoo species do not extend further to the north and east. The eastern Cape, therefore, is a region where many taxa of diverse phytogeographical units reach their limits of distribution. However, the flora of the region has apparently a rather low proportion of endemics (Table 4), suggesting that there has been little speciation here in the recent past.

It is not possible to determine the number of endemic species in a flora whose composition is not yet well known. However, when the number of endemics are found for certain plant groups in the eastern Cape it is shown in Table 4 that the percent of endemic species in these groups falls far below the percent of endemic species in areas well known for high levels of endemism. Furthermore, extracting data from Goldblatt's (1978) list of genera endemic to southern Africa, it is seen (Table 5) that the numbers of species per genus is much lower for genera restricted to the eastern Cape than for endemic genera in all of southern Africa. Moreover, the high number of species per genus in endemic genera which reach the eastern Cape, but have the greater part of their distribution elsewhere, emphasizes once again that the eastern Cape is on the edge of major distribution patterns.

In summary, the diversity of taxa in the eastern Cape is due to combinations of species from different phytochoria meeting at the ends of their ranges, and not a result of speciation taking place in the area.

Phytosociology

Plant community data complement the phytogeographical picture. Acocks (1975) describes 70 veld

TABLE 1.—Distributions of 'tropical' taxa

	EC* endemic spp.	Spp. extending to EC from S&W	Spp. extending from EC both S&W and N&E	Spp. extending to EC from N&E
Grasses (Chippindall, 1955)	11 (5%)	33 (16%)	44 (22%)	116 (57%)
Trees (Coates Palgrave, 1977)	4 (1%)	31 (10%)	82 (25%)	207 (64%)

*Eastern Cape

TABLE 2.—Distributions of south-western Cape taxa

	(Adamson & Salter, 1950) Cape Pen.	(Martin & Noel, 1960) Alb. & Bath.	(Ross, 1972) Natal	(Jacot Guillarmod, 1971) Lesotho
Restionaceae				
Species	86	21	6	2
Genera	10	8	2	1
Proteaceae				
Species	39	10	16	5
Genera	9	4	5	1
	Caledon	Uitenhage	Alb. & Bath.	All Africa
<i>Erica</i> (Baker & Oliver, 1967)				
Species	220	112	12	25

TABLE 3.—Distributions of Karoo-Namib taxa

Mesembryanthemaceae (Herre, 1971)	Karoo-Namib		W. Cape		E. Cape		Natal
Genera	122		46		30		6
<i>Pteronia</i>	NW Cape	SW Cape	Karoo	Little Karoo	S Cape	E Cape	Natal
Species	33	18	16	14	13	9	0

TABLE 4.—Percentages of endemic taxa

	%
Eastern Cape	
Southern African endemic genera (Goldblatt, 1978)	5
Grasses (Chippindall, 1955)	5
<i>Aloe</i> (Reynolds, 1950)	6
<i>Gladiolus</i> (Lewis, Obermeyer & Barnard, 1972)	0
Crassulaceae (Tölken, 1977)	18
<i>Oxalis</i> (Salter, 1944)	3
Trees (Coates Palgrave, 1977)	1
All seed plant species in published volumes of Flora of Southern Africa (Dyer <i>et al.</i> , 1963; Codd <i>et al.</i> , 1966, 1970; Ross 1975, 1976, 1977; Leistner, 1979, 1980)	5
Other areas, of high endemism	
SW Cape (Weimarck, 1941)	83
Cape Floristic Region (Goldblatt, 1978)	73
Namib Desert (Robinson, 1978)	35
All of southern Africa (Goldblatt, 1978)	80

types, which are plant communities or aggregations of communities. Of the 70 veld types, 21 (30%) occur in the eastern Cape. Therefore a region with only about 6.5% of the area of South Africa has more veld types than any other single region (the next most diverse areas of comparable extent are Natal with 16 and the south-western Cape with 10 veld types). Furthermore, no single veld type extends both south-west and north-east from the eastern Cape. Acocks only considered six of the 21 veld types to be restricted to the eastern Cape, and four of these he terms 'false' (man-induced). Edwards's (1977) map of South African biomes shows the same pattern. Eight of the 11 biomes occur in the eastern Cape, not one of which is restricted to the area. All the biomes extend into our area either from the west or from the north and east, and none extends in both directions from the eastern Cape.

As well as the spatial variation in communities, the eastern Cape vegetation is unstable through time. It is all too well known by agriculturalists that many communities are prone to rapid changes in floristic

TABLE 5.—Numbers of species in genera endemic to southern Africa (Goldblatt, 1978)

	No. genera	No. species	Spp./gen.	Standard deviation
Genera restricted to E. Cape	6	7	1,2	0,41
All endemic genera in sth. Afr.	557	4 802	8,6	28,40
Genera reaching E. Cape but not restricted	127	1 841	14,5	28,40

TABLE 6.—Numbers of weed species in various areas of South Africa (Henderson & Anderson, 1966)

Area	Species
Transvaal	116
Orange Free State	69
Natal	82
Eastern Cape	104
Southern Cape	37
Northern Cape	54
Central Cape	33
South-western Cape	51
Widely distributed species	84

TABLE 7.—Weeds, aliens and species of disturbed sites in Albany and Bathurst (Martin & Noel, 1960)

Plant group	Species
Aliens	180
Weeds	40
Of disturbed sites	15
	235
Total flora	2 390
Aliens, weeds, etc	ca. 10%

composition as soon as they are disturbed. The data of Henderson & Anderson (1966) and Martin & Noel (1960) show clearly how readily weeds and alien species become established over much of our area. (Tables 6 & 7). This suggests that many communities may be very sensitive to changes. Of perhaps even greater interest is the way elements of different phytochoria (for example, *Pteronia incana* and *Elytropappus rhinocerotis* of the winter rainfall area, *Pentzia incana* and *Felicia* spp. of the Karoo, and the tropical species of the scrub woodland communities) can invade communities of a range of phytochoria. Although at least some of these invasions are initiated or encouraged by man's activities, the fact that elements of different regions can replace one another emphasizes the dynamic nature of the vegetation as a whole and gives a clue to the possible reason for the apparent lack of speciation in the area.

FACTORS PROMOTING SPECIATION

At this point it is worth reviewing briefly the kinds of environmental and other factors that lead to fragmentation of gene pools and subsequent divergence of sub-populations under various selection pressures. Data for the eastern Cape flora can then be examined

in the light of prevailing environmental conditions and the currently accepted theories of the kinds of environment which favour micro-evolution.

The fragmentation of populations into sub-units as a factor likely to promote speciation has been widely accepted since it was proposed by Wright in 1931. If the sub-units are sufficiently isolated from one another to become differentiated by selection pressures but there is still limited gene flow to retain variability, it may be expected that species complexes will develop (Stebbins, 1972). This condition will be found in regions of marked, fine-scale environmental heterogeneity. Related to this is environmental, particularly climatic, instability over time. Changes in climate can serve to restrict populations to favourable areas, thereby fragmenting the gene pool. As pointed out by Stebbins (1952, 1972 & 1974), as far as higher plants are concerned, water availability is here of critical importance. Raven (1964) showed the effect of edaphic variability and the way it will interact with climatic fluctuation.

The above conditions together underlie the idea that speciation is likely to be rapid at the limits of species distribution ranges. Here, marginal populations are likely to become genetically isolated from the general gene pool and may undergo differentiation. This idea was elegantly proposed by Valentine (1967) under the title of the 'species pump' hypothesis, and has been discussed at some length by Stebbins (1974).

By taking the above points into account, we can describe one sort of environment in which speciation should be actively occurring. This would be a place in which there is considerable variation, in space and time, of a variety of parameters (climate, soil, landscape, etc.) and where many taxa are nearing the limits of their geographical ranges. In addition, the balance of evidence suggests that the climate should be semi-arid (but see Simpson, 1977, for a discussion of speciation in tropical forests). From the description of the physical environment and the vegetation, the eastern Cape seems to meet the above conditions for speciation. However, the flora does not show the expected pattern of diversity in terms of numbers of endemic species.

DISCUSSION

When one looks at the species and communities of the eastern Cape, three features are apparent. First, physiographic and climatic variability result in spatial and temporal heterogeneity on a fine scale. This allows many different species and vegetation types to exist in close proximity to one another and at the same time results in instability of the communities. Second, the distribution ranges of a large number of taxa end here, confirming the recognition of the eastern Cape as the boundary for a number of phytochoria. Third, neither taxa nor syntaxa seem to

have become differentiated enough to be recognized as separate despite the operation of factors that elsewhere lead to speciation or the development of distinct plant communities. There are relatively few plant taxa that are endemic or restricted to the area, and of the six veld types restricted to the eastern Cape only two (Alexandria Forest and Eastern Province Thornveld) are not the result of invasion apparently initiated by man. It must be stressed that much more taxonomic and syntaxonomic information is needed for the area. At present neither the flora nor the communities are adequately treated in any work and the data presented above are crude. In spite of this, it may be in order to examine the situation a little more closely, if only to suggest possible directions for further investigation.

At present there is only scanty palaeoclimatic or floristic data for the eastern Cape, so we have no real idea of how long the conditions now experienced in this area have continued. However, when one considers the changes that have occurred over southern Africa [see for instance Livingstone (1975), Tankard & Rogers (1978) and Lancaster (1979)], and the decade to century long fluctuations commented on by May (1979), there can be little doubt that the eastern Cape climate must have been unstable for a very long time. As indicated earlier, the area is the boundary between the winter and summer rainfall zones, so any change in macroclimate over southern Africa would lead to a dramatic change in conditions. However, on the west coast of southern Africa there is a region which is climatically similar in some ways to the eastern Cape in that the summer and winter rainfall zones meet and there is a variety of habitats. In this area of the north-western Cape and southern Namib a number of taxa show active speciation (Robinson, 1978, Moffett, 1979).

Why then has the eastern Cape not developed a distinctive flora as a result of active speciation? It is possible that the nature of the dominant life forms, the variability of the environment and the position of the eastern Cape between the major phytochoria have all resulted in selection for 'generalist' genotypes rather than producing 'specialists'. Hamrik *et al.* (1979) have shown that woody plants and wind pollinated plants (grasses) show greater genetic diversity within a species on average than do herbaceous and entomophilous ones. Hedrik *et al.* (1976) have shown that heterogeneous environments encourage or maintain high levels of genetic diversity in taxa. Furthermore, it would be expected that of the species making up a phytochorion, the generalists would be more likely to extend to the ends because of their wider tolerances. Therefore, the species in the eastern Cape may tend to be the most genetically diverse representatives of their respective phytochoria.

In other areas where speciation is rapid, it is single species or communities that are reaching the ends of their ranges, whereas in our area it is phytochoria (i.e., assemblages of many species and communities) that are reaching their distribution limits. It is important to remember that the species making up the different phytochoria have evolved under very different selection pressures. This may mean that in an area such as the eastern Cape where a number of phytochoria are adjacent to one another there is a species already present (perhaps most likely a 'generalist') which can occupy virtually any niche that becomes available. Therefore a change in environmental factors will simply lead to movements of species populations to new sites rather than the evolution of new genotypes. This idea is supported

by the effects of fire on macchia vegetation reported by Trollope (1973) and Downing *et al.* (1978). In the Amatole Mountains fynbos species (*Cliffortia linearifolia*, *C. paucistaminea* and *Erica brownleeae*) form dense closed communities. When such fynbos is burned on a regular basis the community changes to grassland dominated by tropical grasses of the genera *Themeda*, *Tristachya* and *Panicum*. At the community level, although Acocks's treatment is too broad to allow more detailed discussion, it may be significant that the 'false' veld types of the eastern Cape are the result of Cape and Karoo phytochoria invading disturbed areas in phytochoria of tropical origin.

This reasoning leads to the conclusion that there is a saturation of the environment by species in such a region, which is apparently contradicted by the large number of weeds and aliens found in most communities in our area. However, most of the weedy species are annuals, a life form that is not well represented in Africa generally, and there may be niches, particularly those produced by man's activities, to which alien taxa are better adapted than any indigenous species.

CONCLUSION

The eastern Cape is floristically rich, with an estimated 3 600–4 000 species, and is phytogeographically and phytosociologically complex, and yet there are few endemic or restricted taxa or vegetation types. We suggest two hypotheses to explain this situation. First, selection pressures, particularly climatic instability, have acted to produce a flora in which 'generalist' genotypes predominate; and second, close proximity of phytochoria of different evolutionary histories ensures that somewhere there is a species already present that can fill, by migration, any new niche which may result from environmental change. Studies to confirm these hypotheses would be of great interest not only to evolutionary biologists but also to agriculturalists because of the practical implications. Much of the eastern Cape is only marginally suitable for agronomy and the natural vegetation is therefore of great significance for agricultural production. Management of such inherently unstable ecosystems for sustained productivity demands detailed knowledge of the environment. The information given in this paper shows that the eastern Cape is a very complex place and that our understanding of its vegetation is far from complete. Studies of the species and communities making up the vegetation will greatly increase the chances that management plans can be made that will take account of the long-term variability which this area exhibits.

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Many of the ideas expressed here were developed while both authors were engaged in various research and teaching posts at the University of Fort Hare and we therefore make acknowledgement to this institution; and especially to Mr W. S. W. Trollope, who has kept us always conscious of the need for practical application of biological study.

UITTREKSEL

Die Oos-Kaap is 'n gebied met veranderlike omgewingsfaktore, 'n flora wat na beraaming 3 600–4 000 spesies bevat en 21 van Acocks (1975) se veldtipes in-

sluit. Dit lê op die grense van die hoof fitochoria wat in suidelike Afrika verteenwoordig is, verskeie tropiese spesies wat die suid- en westelike grense van hulle verspreiding bereik koin voor, terwyl baie suid-westelike Kaap- en Karoo spesies wat die noord- en oostelike grense van hulle verspreiding bereik, daarin gevind word. Die skynbaar lae voorkomssyfer van spesies endemies in die Oos-Kaap kan wees as gevolg van seleksie vir 'algemene' genotipes in die teenwoordigheid van verskillende fitochoria waar inmigrasie van spesies tussen fitochoria kan plaasvind om so-doende nisse te vul wat as gevolg van veranderinge in omgewingstoestande kan ontstaan.

REFERENCES

- ACOCKS, J. P. H., 1975. Veld types of South Africa, 2nd ed. *Mem. bot. surv. S. Afr.* 40: 1–128.
- ADAMSON, R. S. & SALTER, T. M., 1950. *Flora of the Cape Peninsula*. Cape Town: Juta.
- BAKER, H. A. & OLIVER, E. G. H., 1968. *Ericas in southern Africa*. Cape Town: Struik.
- CHIPPINDALL, L., 1955. A guide to the identification of grasses. In D. Meredith, *The grasses and pastures of South Africa*, Part 1. Johannesburg: C.N.A.
- COATES PALGRAVE, K., 1977. *Trees of southern Africa*. Cape Town: Struik.
- CODD, L. E., DE WINTER, B. & KILICK, D. J. B., eds, 1970. *Flora of southern Africa*. 13: 1–221.
- CODD, L. E., DE WINTER, B. & RYCROFT, H. B., eds, 1966. *Flora of southern Africa*. 1: 1–166.
- DOWNING, B. H., ROBINSON, E. R., TROLLOPE, W. S. W. & MORRIS, J. H., 1978. The influence of macchia eradication techniques on botanical composition of grasses in the Dohne Sourveld of the Amatole Mountains. *Proc. Grassld Soc. sth. Afr.* 13: 111–116.
- DYER, R. A., CODD, L. E. & RYCROFT, H. B., eds, 1963. *Flora of southern Africa*. 26: 1–307.
- EDWARDS, D., 1977. Biomes of South Africa. Unpublished map prepared at Botanical Research Institute, Pretoria.
- GIBBS RUSSELL, G. E., 1975. A comparison of the size of various African floras. *Kirkia* 10,1: 123–130.
- GOLDBLATT, P., 1978. An analysis of the flora of southern Africa: its characteristics, relationships and origins. *Ann. Mo. bot. Gdn* 65,2: 360–436.
- HAMRIK, J. L., LINHART, Y. B. & MITTON, J. B., 1979. Relationships between life history characteristics and electrophoretically detectable genetic variation in plants. *Ann. Rev. Ecol. Syst.* 10: 173–200.
- HAUGHTON, S. H., 1963. *Stratigraphic history of Africa south of the Sahara*. Edinburgh: Oliver & Boyd.
- HEDRIK, P. W., GINEVAN, M. E. & EWING, M. P., 1976. Genetic polymorphism in heterogenous environments. *Ann. Rev. Ecol. Syst.* 7: 1–32.
- HENDERSON, M. & ANDERSON, J. G., 1966. Common weeds in South Africa. *Mem. bot. Surv. S. Afr.* 37: 1–440.
- HERRE, H., 1971. *The genera of the Mesembryanthemaceae*. Cape Town: Tafelberg.
- JACOT GUILLARMOD, A. M. F., 1971. *Flora of Lesotho*. Lehre: Cramer.
- LANCASTER, I. N., 1979. Evidence for a widespread late Pleistocene humid period in the Kalahari. *Nature, Lond.* 279, 5709: 145–146.
- LEISTNER, O. A., ed. 1979. *Flora of southern Africa* 10,1: 1–59.
- LEISTNER, O. A., ed. 1980. *Flora of southern Africa* 27,4: 1–91.
- LEWIS, G. J., Obermeyer, A. A. & Barnard, T. T., 1972. *Gladiolus* a revision of the South African species. *Jl S. Afr. Bot. Suppl.* to Vol. 10: 1–315.
- LIVINGSTONE, D. A., 1975. Late Quarternary climatic change in Africa. *Ann. Rev. Ecol. Syst.* 6: 249–280.
- MARTIN, A. R. H. & NOEL, A. R. A., 1960. *The flora of Albany and Bathurst*. Grahamstown: Rhodes University.
- MAY, R. M., 1979. Arctic animals and climatic changes. *Nature Lond.* 281, 5728: 177–178.
- MOFFETT, R. O., 1979. *Sarcocaulon* and the Gariep: products of a hostile environment. Paper presented to the 5th Annual Congress of the South African Association of Botanists, 24–27 January, 1979, Stellenbosch.
- OLIVER, E. G. H., 1977. An analysis of the Cape flora. *Proceedings of Second National Weeds Conference of South Africa*, 1–18. Cape Town: Balkema.
- RAVEN, P. H., 1964. Catastrophic selection and edaphic endemism. *Evol.* 18(2): 336–338.
- REYNOLDS, G. W., 1950. *Aloes of South Africa*. Johannesburg: The Aloes of South Africa Book Fund.
- ROBINSON, E. R., 1978. Phytogeography of the Namib Desert of South West Africa (Namibia) and its significance to discussions of the age and uniqueness of this desert. In E. M. van Zinderen Bakker Snr & J. A. Coetzee, eds, *Palaeoecology of Africa and the surrounding islands* Vol. 10/11: 67–74. Rotterdam: Balkema.
- ROSS, J. H., 1972. Flora of Natal. *Mem. bot. Surv. S. Afr.* 37: 1–418.
- ROSS, J. H., ed., 1975. *Flora of southern Africa* 16,1: 1–159.
- ROSS, J. H., ed., 1976. *Flora of southern Africa* 22: 1–161.
- ROSS, J. H., ed., 1977. *Flora of southern Africa* 16,2: 1–142.
- SALTER, T. M., 1944. The genus *Oxalis* in South Africa. *Jl S. Afr. Bot. Suppl.* to Vol. 1: 1–355.
- SIMPSON, B. B., 1977. Biosystematics and geography. In J. A. Romberger, ed., *Biosystematics in agriculture. Beltsville Symposium in Agricultural Research* 2: 151–172.
- SOGA, J. H., 1931. The Ama-Xosa: life and customs. Alice: Lovedale Press.
- STEBBINS, G. L., 1952. Aridity as a stimulus to plant evolution. *Amer. Natur.* 86: 33–44.
- STEBBINS, G. L., 1972. Ecological distribution of centers of major adaptive radiation in angiosperms. In D. Valentine, ed., *Taxonomy, phytogeography and evolution*. New York: Academic Press.
- STEBBINS, G. L., 1974. *Flowering plants, evolution above the species level*. London: Edward Arnold.
- TANKARD, A. J. & ROGERS, J., 1978. Late Cenozoic palaeoenvironments on the west coast of southern Africa. *J. Biogeogr.* 5: 319–337.
- TOLKEN, H. R., 1977. A revision of the genus *Crassula* in southern Africa. *Contr. Bolus Herb.* 8, 1 & 2: 1–595.
- TROLLOPE, W. S. W., 1973. Fire as a method of controlling macchia (fynbos) vegetation on the Amatole Mountains of the eastern Cape. *Proc. Grassld Soc. sth. Afr.* 8: 35–42.
- U.N.E.S.C.O./A.E.T.F.A.T., 1980. Vegetation map of Africa (sheet 4). (In press).
- VALENTINE, J. W., 1967. The influence of climatic fluctuations on species diversity within the tethyan provincial system. In G. C. Adams & D. V. Ager, eds, *Aspects of tethyan biogeography. Systematics Assn Publ.* 7: 153–166.
- WEATHER BUREAU, 1965. *Climates of South Africa, part 8, general survey*. Weather Bureau WB 28.
- WEIMARCK, H., 1941. Phytogeographical groups, centres and intervals within the Cape Flora. *Lunds Universitets Arsskrift*, N. F. Avd. 2 Bd. 37, Nr. 5: 1–143.
- WERGER, M. J. A., 1978. Biogeographical division of southern Africa. In M. J. A. Werger, ed., *Biogeography and ecology of southern Africa*. The Hague: Junk.
- WRIGHT, S., 1931. Evolution in Mendelian populations. *Genetics* 16: 97–159.

Information available within the PRÉCIS data bank of the National Herbarium, Pretoria, with examples of uses to which it may be put

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ABSTRACT

The contents of the computerized information storage and retrieval system (PRÉCIS) of the National Herbarium, Pretoria (PRE) are described at length mainly by means of frequency histograms of descriptor codes. The frequency distributions found are discussed in the light of the history of the herbarium, the geography of the area and the habits of plant collectors. Two uses of PRÉCIS are illustrated by example. Firstly, the flowering phenology of *Eragrostis capensis*, *Themeda triandra* and *Heteropogon contortus* is plotted and, secondly, the route followed by Dinter in South West Africa/Namibia from December 1933 until March 1935 is described. It is concluded that the system should be of particular use in revisionary studies, regional floras and biogeographic research.

RÉSUMÉ

INFORMATION DISPONIBLE DANS LE DÉPÔT DE DONNÉES PRECIS DE L'HERBARIUM NATIONAL DE PRETORIA, AVEC DES EXEMPLES D'UTILISATION AVEC LAQUELLE IL PEUT ÊTRE EMPLOYÉ

Les contenus d'un dépôt d'informations sur ordinateur et un système de recouvrement (PRECIS) de l'Herbarium National de Pretoria (PRE) sont décrits tout au long, principalement au moyen d'histogramme de fréquence de codes de description. Les distributions de fréquence trouvées sont discutées à la lumière de l'histoire de l'Herbarium, la géographie de la région et les habitudes des collectionneurs de plantes. Deux utilisations du PRECIS sont illustrées par des exemples. Premièrement la phénologie de la fleur d'*Eragrostis capensis*, *Themeda triandra* et *Heteropogon contortus* est située et, deuxièmement, la route suivie par Dinter au Sud-Ouest africain/Namibia, de Décembre 1933 jusqu'à Mars 1935 est décrite. On tire la conclusion que le système devrait être particulièrement utile pour des études de révision, les flores régionales et la recherche biogéographique.

INTRODUCTION

Over the past eight years a computerized data banking system for the National Herbarium (PRE) has been designed, programmed and data have been loaded. The entire project has been completed recently and this communication is intended to describe the scope of the information contained in the data base, attempt to account for its shortcomings and to give examples of results that can be derived from it. A knowledge of what is available will enable prospective users to design their enquiries efficiently and will indicate what can and cannot be extracted from the data bank. It is not our intention to present new taxonomic, floristic or ecological results, based on this information, but merely to summarize it for the benefit of future users and to highlight a few of the possible uses of the system through examples.

The aim of the project was to encode all the information from the approximately half million herbarium specimens collected in the Flora of Southern Africa Area and housed in the National Herbarium, Pretoria, and to produce a flexible information retrieval system by means of which the data could be made available in a number of useful forms. A systems analysis (Morris, 1974), progress reports (Morris & Leistner, 1975; Morris & Glen, 1978) and a description of the backlog encoding task (Morris, 1980) have traced the development of the system.

The frequency of occurrence of each descriptor on herbarium specimens, i.e. how many specimens had an indication of flower colour or notes on habitat, was unknown when this data bank was designed. The net was thrown extremely wide with the intention

that as much data as possible would be captured in retrievable form. Of great use to the designers of future systems will be knowledge of the frequency of occurrence of descriptors in a herbarium of the size and scope of ours. It is a great waste of computer disk storage space if provision is made on every specimen record for a particular descriptor which has a low frequency, i.e. is missing or absent most times, and more efficient storage procedures can be used in those cases. Frequency of occurrence of descriptors for specimens housed in the National Herbarium are summarised below, together with brief comments on the distributions found.

Many uses of this and other such computerized herbarium data banks have been proposed (see e.g. Crovello, 1972). Two uses which are particularly suited to this approach are countrywide phenological studies and the reconstruction of routes followed by early collectors. We present a preliminary account of the flowering times of three widespread grass species and notes on the probable route followed by Dinter in South West Africa/Namibia on his last visit to the territory as examples of the kind of information that is now available from PRÉCIS.

CONTENTS OF THE DATA BANK

General

At the time when the statistics given below were extracted, 496 909 backlog specimens had been loaded into the data bank. Although the system makes provision for the continuous addition of new collections (see Morris & Glen, 1978) and about 10 000 are being accessioned annually, those that had been added by means of the new plant collection form were deliberately excluded from this analysis. Some 4 100 additional backlog specimens, still to be loaded at the

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time, have since been accessioned. We consider it unlikely that these omitted specimens will significantly alter the results presented.

A complete list of descriptors and codes is given in Morris (1980). This list should be consulted in conjunction with this paper.

Geographical distribution of specimens

(a) Region

The distribution of specimens by region is given in Fig. 1. All specimens from the Flora of Southern



FIG. 1.—Distribution of specimens by region. Numbers in the left-hand column indicate numbers of specimens in each region and bars represent proportion, scaled by the maximum, of specimens in each region. Similar conventions are used in all following figures of this kind.

Africa area as well as all type specimens in the herbarium were encoded, explaining the relatively small number of specimens from Angola, Mozambique and Rhodesia/Zimbabwe in the herbarium. It is surprising that there are more Cape specimens housed in the herbarium than there are Transvaal ones as the herbarium is situated in the Transvaal and another three large herbaria serve the Cape Province. Although the Cape has a longer botanical history than the Transvaal, it is only during the latter parts of this century that large numbers of specimens have been collected so that this cannot be advanced as a reason for this disproportionate distribution of specimens. Natal and South West Africa/Namibia are better represented than the Orange Free State and neighbouring independent countries (Swaziland, Lesotho and Botswana).

An indication of the intensity of collection may be obtained from a study of the number of specimens collected per square km of each region. In Fig. 2 pie charts are used to indicate the number of specimens

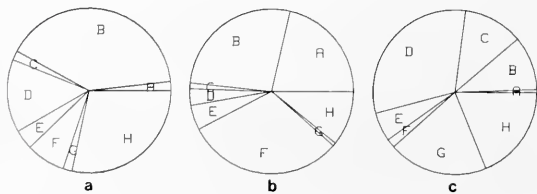


FIG. 2.—Pie charts of: a, number of specimens per region; b, areas of regions; c, number of specimens per square km of each region. (A = Botswana, B = Cape Province, C = Lesotho, D = Natal, E = Orange Free State, F = South West Africa, G = Swaziland and H = Transvaal.)

per country and province of South Africa falling within the Flora of Southern Africa Area (Ross *et al.*, 1977), the area of that geographic unit and the number of specimens collected per unit area of the region. The largest regions, Botswana, Cape Province and South West Africa, are less collected on the basis of number of specimens per unit area than Transvaal, Natal and Swaziland, the last two being very small in area compared with most other regions. Botswana, South West Africa and the Orange Free State are particularly undersampled by this criterion.

(b) Grid references

Grid references have only been given to specimens on a regular basis since the development of the quarter degree grid reference system by Edwards & Leistner (1971) and thus we anticipated that a large proportion of the collection would be without this useful geographic identifier. Of the total, 10.5% had codes when they were accessioned. Many more specimens with grids have been collected in the Transvaal than in any other region. An attempt is being made at present to automatically assign grids to the specimens without grids on the basis of region and major and minor locations.

(c) Major and minor locations

A total of over 41 300 major and minor locations have been used by collectors. A page of examples of localities is given in Table 1. It is our intention to remove synonymous names and correct spelling mistakes in the collector and locations files in due course.

Curatorial information

(a) Year collected

The dramatic, almost linear, increase in the number of specimens accessioned annually after 1880 is illustrated in Fig. 3. Factors contributing to the rapid increase include the appointment of J. Burtt Davy as Government Botanist in Pretoria in May 1903 and the establishment of the Botanical Survey Advisory Committee by I. B. Pole Evans during 1918 (Dyer, 1977). The former led to the foundation of what is now known as the National Herbarium (PRE) and the latter to the appointment of ecologists who have collected widely as part of their brief. The effect of World War II on collections is clearly shown by the drop in accessions from 1936 to 1945. During the five-year period before encoding began (1971–1975) about 9 600 specimens were collected and accessioned annually. The decrease in the last period plotted (1976–1980) is attributed to curatorial activities being concentrated on the preparation of the herbarium for encoding rather than on the accessioning of new material.

The oldest specimens housed in the herbarium include about 150 collected by Burchell between 1810 and 1815. Ecklon, Zeyher and Drège are responsible for the relatively high peak in collecting from 1825 to 1830 and the continuation of activity until 1840 (Fig. 3). These three collectors are represented by a total of 8 000 specimens in the herbarium, spanning the years 1826 to 1850. Alexander, who later changed his name to Prior, collected 1 100 specimens (housed in PRE) from 1846 to 1850. The collections of Wahlberg account, in part, for the peak during the five-year period 1856–1860.

TABLE 1.—Examples of localities from PRÉCIS. The columns on the right give the number of times the name is used as a major and minor location, respectively

Locality	Province/Country	As major location	As minor location
Lusikisiki Div.	Cape Province	1	1
Lusikisiki For. Dist.	Cape Province	1	0
Lusikisiki Dist.	Cape Province	1	0
Lusizi	Cape Province	0	1
Luslington Mt	Cape Province	0	1
Lusoti Hill	Swaziland	3	3
Lusthof	O.F.S.	0	4
Lusthof Ou 243 Farm	S.W.A.	0	1
Lusthof 707 Farm	O.F.S.	2	2
Lustorville Dist.		1	0
Lutambasee		0	3
Lutembure	Transvaal	1	1
Lutembwe	Transvaal	1	1
Lutembwe Aansluiting	Transvaal	1	1
Luther Peak	Cape Province	0	1
Lutheran Mission Sta.	Natal	0	12
Luthle	Botswana	1	2
Lutindi		1	1
Lutombi	Angola	1	1
Luttig	Cape Province	0	2
Lutzputs	Cape Province	3	8
Lutzville	Cape Province	5	2
Luve	Swaziland	0	2
Luvimbi	Transvaal	1	1
Luvuvhu	Transvaal	0	2
Luwinga Dist.	Rhodesia	2	1
Luxillo	Angola	0	1
Luyengo	Swaziland	0	2
Luyengo College of Agriculture Farm	Swaziland	4	5
Luyengo College of Agriculture Farm	Swaziland	0	1
Luyengo College of Agriculture Farm	Swaziland	0	1
Lwamondo Location	Transvaal	0	1
Lwandle	Swaziland	0	2
Lwandle Township	Cape Province	0	1
LWS Farm	S.W.A.	0	1
Lydenburg	Transvaal	1	0
Lydenburg Dist.	Transvaal	0	1
Lydenburg	Transvaal	1 234	1 086
Lydenburg Dist.	Transvaal	340	115
Lydenburg Dist.	Transvaal	2 990	1 063
Lydenburg Dist.	Transvaal	74	34
Lydenburg Dist. Sekukuniland	Transvaal	2	0
Lydenburg Div.	Transvaal	2	1
Lydenburg Div.	Transvaal	9	10
Lydenburg East Dist.	Transvaal	1	0
Lydenburg Town	Transvaal	2	3
Lydenburg	Transvaal	0	1
Lydenburgpas		0	0
Lydiana	Transvaal	0	9
Lyds Pass	Cape Province	1	1

(b) *Contributions from the Cape and Transvaal to the herbarium*

It has been shown above that there are more Cape Province specimens in the herbarium than Transvaal ones, even though the herbarium is situated in, and primarily serves, the Transvaal. In Fig. 3, the proportions of Cape and Transvaal specimens to the total over five-year periods are plotted. Until 1915 there are proportionally far more Cape specimens than Transvaal ones in the herbarium. At that time the proportions from both provinces stabilize at about 0.4 each and then decrease slightly to between 0.2 and 0.4 at the present time. For nearly all periods after 1915 the proportion of Cape specimens still remains higher than that of Transvaal specimens. Exceptions are from 1916–1920 and 1941–1945, both

times of world war. The gradual decreases in both proportions in recent years suggest the increasing accession of specimens from other regions. The relatively low proportion of Cape specimens during 1871–1875 is partly due to active collection by Rehmann in Natal during that period. It is not known who was active in the Transvaal during the period 1886–1890 and responsible for the large proportional contribution of Transvaal specimens during that period, but the collections of Galpin from Barberton (Phillips, 1930) will undoubtedly contribute to the total.

(c) *Month of collection*

A clear summer peak in collecting activity is seen from the distribution of specimens by month of col-

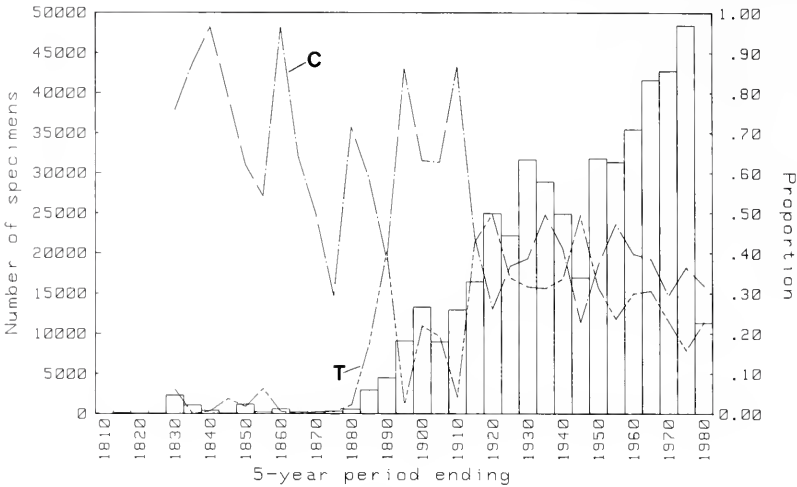


FIG. 3.—Histogram of number of specimens accessioned during successive five-year periods from 1806. The proportions of Cape (C) and Transvaal (T) specimens to the total are also indicated for each period.

lection (Fig. 4a). Slightly fewer collections than expected during February may be caused by there being fewer days for collecting during that month. Holidays during December may have influenced the number of collections during that month. The pattern in the Transvaal is similar with a maximum in January and very little collecting activity from May until September (Fig. 4b). In the Cape, on the other hand, where most collecting has been done in the winter-rainfall part of the Province, a more equable distribution of specimens by month of collection is found with a clear peak in September (Fig. 4c).

(d) *Distribution of types*

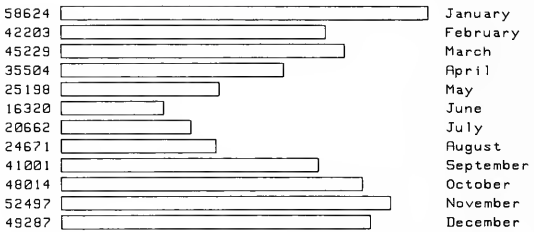
A type code is assigned to 2% of the specimens in the data bank. Nearly half of these specimens are types (46%), while 26% are isotypes, 15% holotypes and the other 12% are syntypes, paratypes and lectotypes (Fig. 5). Only 36 specimens received a neotype code. It is likely that more type specimens are housed in the herbarium. Those reflected here are those identified as such on labels and exclude those that have not yet been annotated.

(e) *Duplicates*

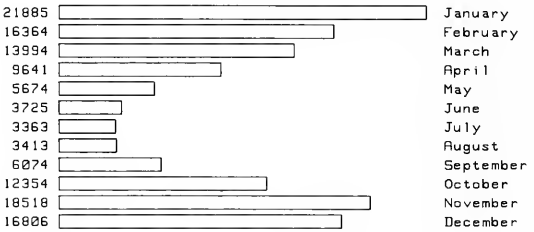
When more than one sheet of a specimen (i.e. of the same collection) was found together by the encoders, the number of duplicates was recorded. This information is required by the curator so that he will know how much space in cabinets is taken up by duplicates. Two percent of the collection have more than one sheet filed. Eighty-one percent of these specimens have two duplicates and very few specimens are represented by more than three duplicates.

(f) *State of specimen*

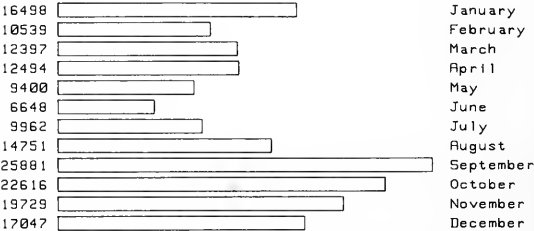
Ninety-seven percent of the specimens received a flower code for state of specimen. Seventy-three percent of these specimens had mature flowers, 15% were coded with flowers present, 11% with flowers absent and only 1% of the specimens had immature flowers (Fig. 6a). A surprisingly large proportion of specimens have flowers (89% including both immature or mature flowers). Ninety-five percent of the specimens have a code for fruit (Fig. 6b). Immature fruit occur on 57% of the specimens, 15% of the specimens are coded with fruit present and 20% of the specimens have mature fruit. Only 8% of the



a



b



c

FIG. 4.—Distribution of specimens by month of collection: a, all regions; b, Transvaal; c, Cape Province.



FIG. 5.—Distribution of specimens by type status.

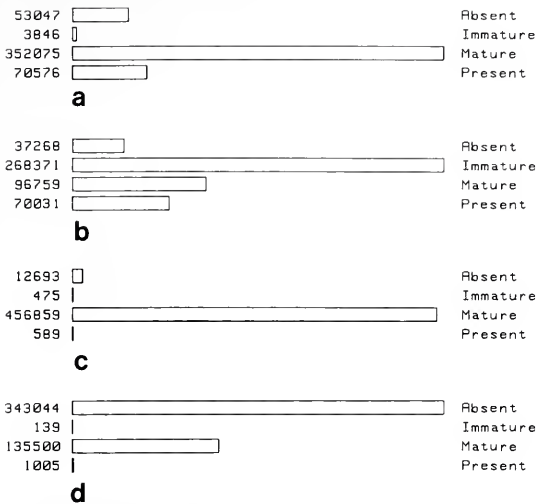


FIG. 6.—Distribution of specimens by state of specimen: a, flower; b, fruit; c, leaf; d, root.

specimens have fruit absent. A leaf code is assigned to 97% of the specimens, of which, again 97% have mature leaves. Leaves are absent from only 3% of the specimens (Fig. 6c). Ninety-seven percent of the specimens have a code for presence of roots. Seventy-two percent of these specimens have no roots and 28% have mature roots.

(g) Language used on label

Eighty-six percent of all the collections have labels in English in comparison with the 6% which are in Afrikaans (Fig. 7). Even higher percentages of the

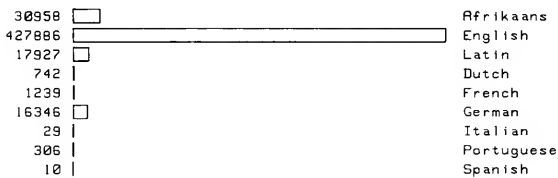


FIG. 7.—Distribution of specimens by label language.

collectors use English in Natal (95%), Botswana (96%), Lesotho (98%) and Swaziland (98%). Thirty-two percent of the collectors in South West Africa use German.

Plant descriptors

(a) Abundance and distribution

Twenty percent of the specimens have an abundance code. Over 50% of these are common, 17% are very rare and rare, 18% occur occasionally and 12% of the specimens are abundant (Fig. 8). A distribution code (i.e. widespread/local) is assigned to 20% of all specimens collected. Eighty-six percent of these specimens are coded as widespread and 14% have a local occurrence.

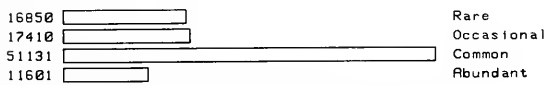


FIG. 8.—Distribution of specimens by abundance code.

(b) Flower and fruit colour

Thirty percent of the specimens have a flower colour code and nearly 30% of these have yellow flowers (Fig. 9a). Twenty-seven percent of the specimens have white or cream flowers, 13% mauve or purple flowers and 10% have pink flowers. There are very few specimens with grey, orange or brown flowers and only 138 specimens are recorded with black flowers. A flower code is given to over 50% of the specimens collected in Lesotho (52%) and 50% of the Swaziland specimens have a flower colour code. Both these percentages are significantly higher than the overall average.

A fruit colour code is assigned to only 1% of the total number of specimens. Thirty percent of these specimens have red fruits while 24% have green fruits (Fig. 9b). Only 80 specimens were recorded with blue fruits and 57 specimens have grey fruits. The fact that red fruit occurs more frequently than any other colour fruit can probably be explained by the way that many seeds and fruit are distributed. Birds and small mammals are attracted by brightly coloured fruits, red in particular. Another consideration in connection with fruit colour is that collectors are apt not to record usual colours, such as green and brown, and only note unusual colours.

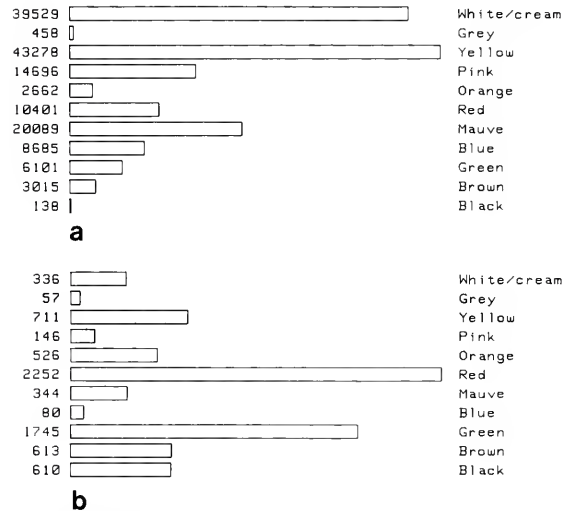


FIG. 9.—Distribution of specimens by: a, flower colour; b, fruit colour.

(c) Life form

A life form code is given on 25% of the specimens. Of these, 36% are shrubs (Fig. 10a), 27% herbs and 19% trees. Distribution by life form for specimens from the Transvaal is similar to that of the total sample but that for the Cape suggests, as one would expect, the presence of fewer trees and many more shrubs in the Cape than in the country as a whole (Fig. 10b).

(d) Annual/perennial code

Four percent of the specimens have an annual/perennial code. Over 60% of the specimens are perennial while 37% are indicated as being annual. Very few specimens had either ephemeral or biennial codes. Relatively high percentages of the specimens are perennial in Natal (86%), the Orange Free State (82%), Lesotho (81%) and Swaziland (92%). In

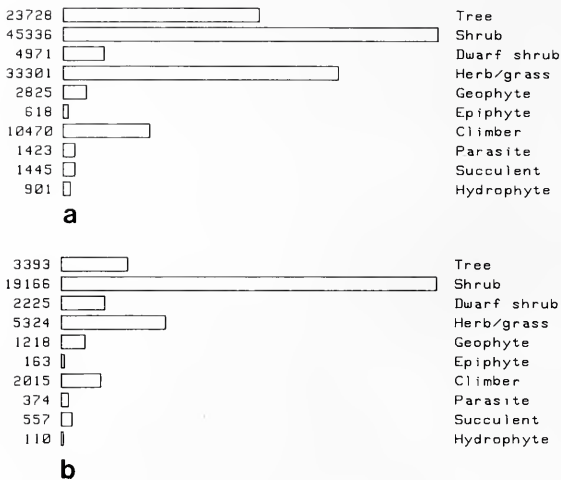


FIG. 10.—Distribution of specimens by life form code: a, entire collection; b, Cape specimens only.

comparison with this, 64% of the specimens in South West Africa are annual, compared with 36% which are coded as perennial.

(e) *Woody/herbaceous code*

A woody/herbaceous code is assigned to only 1% of the specimens. Seventy-eight percent of these specimens are woody and 22% are herbaceous. No specimens are coded as half-woody although there is a code assigned for such a descriptor.

(f) *Evergreen/deciduous code*

An evergreen deciduous code is given to only 1 214 of the specimens. Of these, 53% are evergreen, 44% deciduous and only 2% are coded as semi-deciduous. In Lesotho, 100% of the specimens with this descriptor are evergreen while 100% of the specimens in Botswana are deciduous.

(g) *Weed status code*

Only 1% of the specimens have a weed code. Ninety-eight percent of these specimens are encroachers and only 13 specimens are coded as exotic plants. This latter information is usually obvious from the name of the plant, accounting for the very low frequency with which the information was recorded separately on the label.

(h) *Height and diameter at breast height*

A height code is assigned to 18% of all the specimens. Forty-four percent of these specimens are in

the range of 0–0,5 m (0–1,6 ft). Another 45% (Fig. 11a) of the specimens occur with a steep and then gradual decrease in numbers to 3,5 m (11,5 ft). The remaining 11% are higher than 3,5 m. An interesting fact is that specimens are clustered at certain heights, indicating rounding off by the collectors of the heights of the plants that they collect. Peaks in the number of specimens occur at 4,5 m (about 14 ft), 6 m (20 ft), 7,5 m (25 ft), 9,0 m (30 ft), 10,5 m (35 ft), 12,25 m (40 ft), 13,75 m (45 ft), 15,25 m (50 ft), 17,0 m (55 ft), 18,5 m (60 ft) and at 20,0 m (65 ft). As most specimens were collected before metrication, the heights in feet given above possibly indicate the midpoints of common height estimation ranges used by collectors.

Nineteen percent of all plants coded as being ‘woody’ have a height code and 22% are in the range 0–0,25 m (0–0,8 ft) and 25% are in the range of 0,26–0,5 m (0,8–1,6 ft). Once again, there is a sharp drop in the number of specimens higher than 0,50 m up to about 3 m (Fig. 11b). In the case of woody plants, even sharper peaks occur at certain heights than with all specimens together.

In Lesotho, where 17% of the specimens have a code for height, 73% are in the range 0–0,5 m and 19% in the range 0,51–1,00 m. Only 28 specimens of height 1,01–1,5 m, 31 of height 1,51–2,0 m and 13 of height 2,01–2,5 m have been collected (Fig. 11c). Almost no specimens had a height code greater than 2,5 m in Lesotho where, anyway, only 60 specimens are given a code of ‘tree’ for life form.

Diameter at breast height (DBH) is recorded on only 1 901 specimens, all of which are also coded as woody. Most specimens have a DBH of less than 0,5 m (Fig. 12) with additional peaks at 1,2–1,3 m (about 4 ft) and 1,8–1,9 m (6 ft). There are 158 specimens with a DBH greater than 2,0 m.

Habitat and vegetation features

(a) *Substrate*

Only 24% of the specimens have an indication of substrate type and 88% of these specimens are collected from either soil or stony soil. Bare rock, cliff faces and beach dunes are equally well represented (3% each) and in water is recorded for 2 040 specimens (2%). In South West Africa, desert dunes are recorded on 5% of the specimens and in Natal cliff face is recorded on 6% of specimens and beach dunes on 7%.

(b) *Moisture regime*

Only 12% of the specimens have a moisture regime code. From the distribution of codes, it is clear that

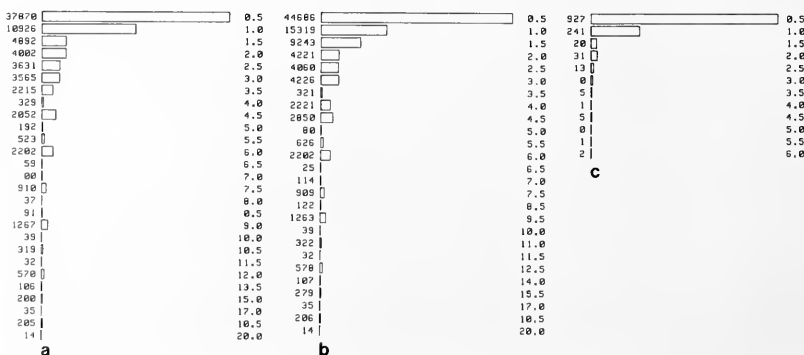


FIG. 11.—Distribution of specimens by height class. Numbers on right indicate ends of 0,5 m class intervals. a, all specimens; b, only specimens with a code for woody; c, for all specimens from Lesotho.

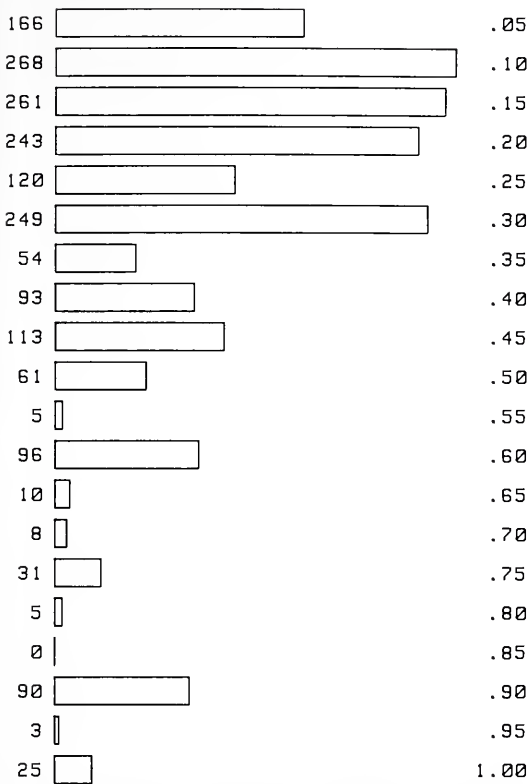


FIG. 12.—Distribution of specimens by diameter at breast height (DBH). Numbers on right indicate ends of 0.05 m class intervals.

only unusual situations, e.g. stream banks, marsh/swamp and pan/depression are recorded by collectors. Dry river beds in South West Africa are well sampled in this category.

(c) Soil type and soil colour

A soil type code is assigned to only 4% of the specimens. Of these, over half (56%) are collected from sandy soil. Other categories with over 5% representation are gravel (7%), loam (13%), clay (9%) and calcrete (8%).

A disappointing 3% of specimens have soil colour of the A-horizon codes and only 99 specimens have B-horizon soil colour codes. Fifty percent of the A-horizon soil colours are red.

(d) Biotic effects

Biotic effects codes are assigned to only 2% of the specimens. The distribution gives an insight into the plant collecting habits of botanists. Nearly half the specimens with codes (44%) are collected alongside roads and railway lines while 19% are from gardens (Fig. 13). Eleven percent of the specimens are from recently burnt areas. Encoders were specifically told not to encode 'on road to ...' as a biotic effect (Mor-

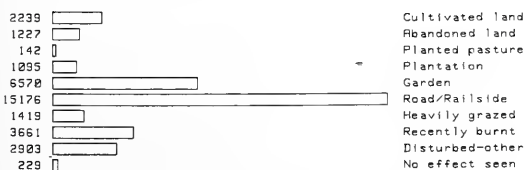


FIG. 13.—Distribution of specimens by biotic effects code.

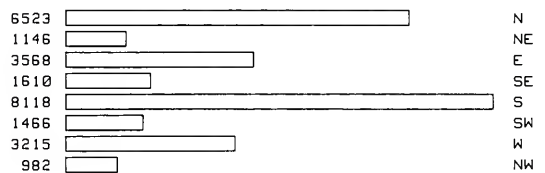
ris, 1980) and that 'collected near road' or a similar statement was needed before code 06 could be assigned and it can therefore be concluded from these statistics that roadside collecting is a major activity of plant collectors. Other favourite collecting sites appear to be gardens, recently burnt veld and disturbed areas (Fig. 13).

(e) Aspect

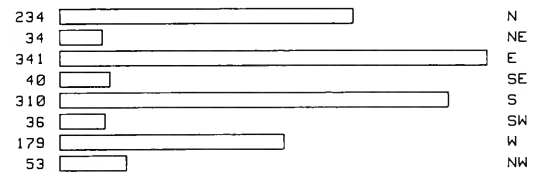
It was expected that compass points would be equally represented. The results, however, show that many more specimens are collected from south-facing habitats than any others (Fig. 14) and that the four cardinal points are far better represented than the four intermediate points. The distribution is even more exaggerated in the Orange Free State (Fig. 14b). The results indicate guessing by collectors to the nearest 90°, and often to the nearest 180°. It is not known why south is the most commonly-collected aspect but it is thought that south-facing slopes, with more mesic conditions and often forest patches, will have higher species diversities and therefore have more species to be collected from them. The bias is particularly marked in the Cape (Fig. 14c). Most even distribution by aspect is shown by specimens from Natal and South West Africa. Relatively few specimens are, however, collected from NE- and NW-facing slopes in South West Africa.

(f) Slope

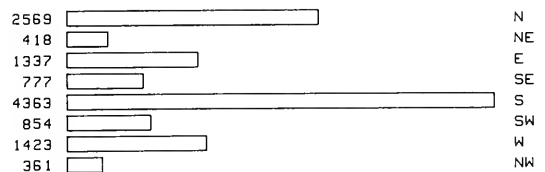
Four percent of the specimens have a code for slope, over 60% of which are level. A further 25% are recorded from steep slopes and 10% from gentle slopes. Specimens from South West Africa (96%), Botswana (93%) and the Orange Free State (75%) are virtually all collected from level sites, whereas about 50% of the Natal specimens, 55% of Lesotho specimens and 55% of Swaziland specimens are from steep slope sites, as would be expected from a knowledge of the topography of these areas.



a



b



c

FIG. 14.—Distribution of specimens by aspect: a, all specimens; b, specimens from the Orange Free State; c, from the Cape Province.

(g) Altitude

Nearly 40% of the specimens have an altitude, indicating the importance attached to altitude by plant taxonomists. As expected, close agreement between known geographic altitude ranges of the provinces and altitude at which plants are collected is found. Overall, there is evenly-spread collecting from sea level to 1 500 m (Fig. 15a) and then a sharp decrease in collecting intensity. In the Cape the decrease is more gradual but starts at 600 m (Fig. 15b). In the Transvaal, collecting decreases on either side of the 1 400 m contour (Fig. 15c), a pattern also shown by the Orange Free State, only in a more extreme form. In Natal, 52% of specimens have altitudes. A number of small peaks are shown, possibly corresponding with the altitudes of botanical survey areas (Fig. 15d) or towns with active collectors. Collecting continues in the Drakensberg to at least 3 200 m although the distribution is only plotted as far as 2 300 m. Collecting at high altitudes is a feature of mountainous Lesotho (Fig. 15e).

(h) Vegetation and veld type

A vegetation code is given to 21% of the specimens. Of these specimens, nearly half are coded as grassland. Taken together, woodland, savanna and scrub/thicket formations account for a further 30% and forest for 20% (Fig. 16). Desert, with only 363 specimens, karoo (including semi-desert) and fynbos are particularly undersampled. Bearing in mind the large area covered by karoo vegetation in South Africa, it has been poorly collected. On the other

hand, as habitat and species diversities are lower in the drier parts of the country, a lower sampling intensity is to be expected there.

In Table 2 a representation of specimens by veld types (Acocks, 1975) for the four provinces of South Africa is given. The sample is small as only 3.1% of the specimens are assigned veld types. In the table the number of specimens from each province and the total for the country are given for each veld type and then the number of specimens collected per 100 km² of that veld type is given as a measure of collecting intensity. Veld type areas were obtained from Edwards (1974). Eleven veld types (Kalahari Thornveld, Mixed Bushveld, Sourish Mixed Bushveld, Karroid Broken Veld, Arid Karoo, Succulent Karoo, Orange River Broken Veld, False Upper Karoo, Highland Sourveld, *Cymbopogon*—*Themeda* Veld and Dry *Cymbopogon*—*Themeda* Veld) cover half the area of South Africa and yet only 14% of the specimens with veld types were collected from them indicating again the uneven distribution of collection effort. Five of the large veld types listed above are either Karoo or False Karoo types, whereas the largest, Kalahari Thornveld, is an arid region tropical bush and savanna type. Therefore the under-collection of the more arid parts of South Africa, shown from an analysis of codes assigned to vegetation, is confirmed by this analysis of specimen distribution by veld type.

Macchia and Coastal Macchia have the greatest number of specimens collected from them and also the highest collection frequency. The high collection

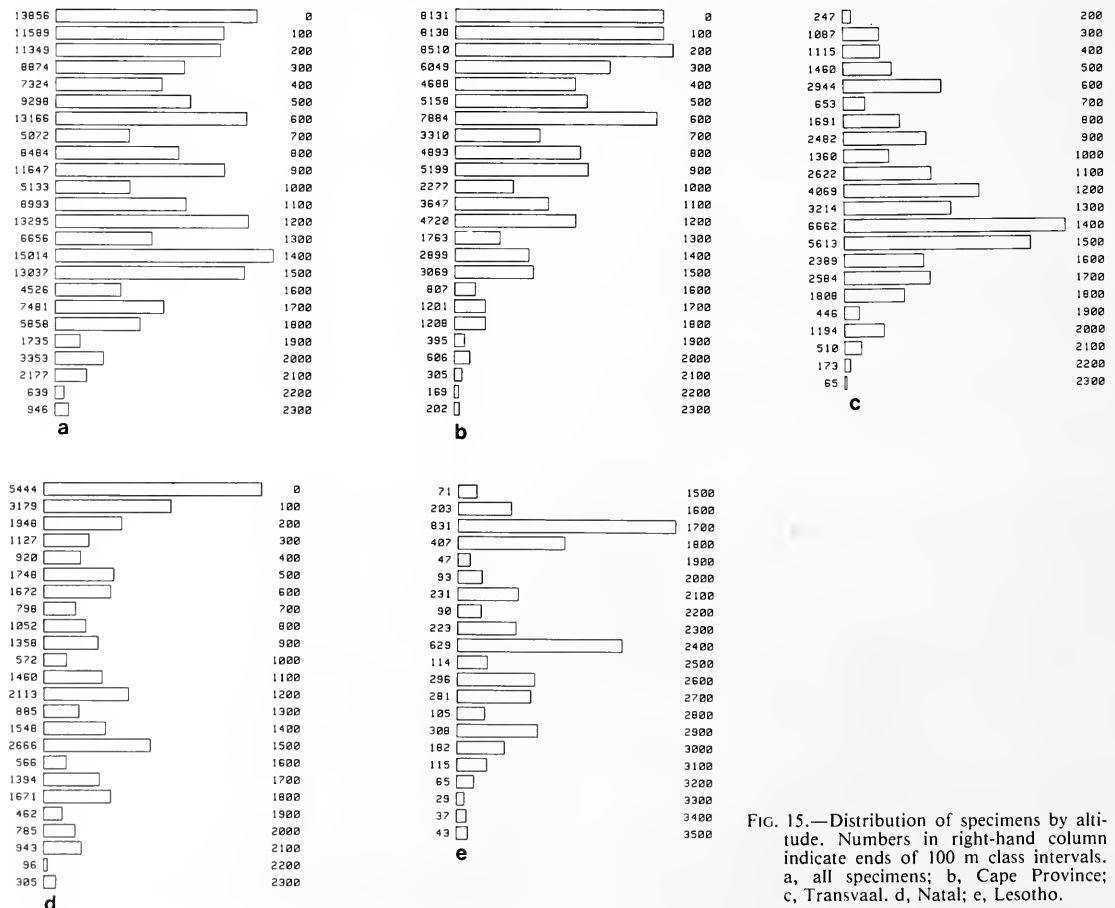


FIG. 15.—Distribution of specimens by altitude. Numbers in right-hand column indicate ends of 100 m class intervals. a, all specimens; b, Cape Province; c, Transvaal. d, Natal; e, Lesotho.

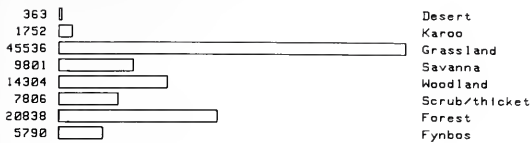


FIG. 16.—Distribution of specimens by vegetation type.

frequency for *Themeda* Veld to Highland Sourveld Transition in Natal is due to the small area covered by this veld type (52 km²) and the relatively large number of specimens collected from it (25). The high collection frequencies for Pondoland Sourveld in Natal (14 specimens/104 km²), *Themeda* Veld to *Cymbopogon*—*Themeda* Veld transition in Transvaal (54/419) and Highland Sourveld to *Cymbopogon*—*Themeda* Veld in Natal (20/104) can be similarly explained. In the Cape, other well-represented veld types are from the smaller Karoo, Karroid Bushveld, False Karoo and temperate and transitional forest and scrub types. In the Transvaal, bushveld and the tropical bush and savanna types are well collected. There are few specimens with veld types from the Orange Free State and most are from False Upper Karoo, Highland Sourveld and pure grassveld types. In Natal, well-represented veld types include Coastal Tropical Forest types, Valley Bushveld, Highland Sourveld and Pure grassveld types.

A small amount of mis-coding of specimens is bound to occur in a project of this magnitude. Thus seven specimens of Coastal Forest and Thornveld, coded as being from the Orange Free State, were obviously given either the wrong Region code or the wrong veld type code. Similarly, Mopani Veld (4 specimens) does not occur in Natal. Where a veld type does not occur in a province, specimens recorded for that veld type in the province were omitted in Table 2. A total of 602 specimens (3.9% of specimens with veld type codes) was excluded in this way. Presence of such errors in the data bank should not

prevent users from deriving valuable information from it. General trends should be sought and not exceptions or obvious errors.

Encoding rules and collector's biased knowledge can explain some of the results presented above. Some veld types are inherently easier to identify than others (e.g. Mopani Veld, Macchia) and they will, therefore, tend to be noted on collecting labels more often than small, obscure ones, identifiable by specialists alone. The close correspondence between the number of specimens coded as vegetation: fynbos and veld type: Macchia is not surprising because the encoders were taught that the terms are synonymous, and where one code was used, the other was normally also encoded.

Economic botany data

(a) Actual-potential use

An actual-potential use code is given to only 2% of the specimens. Ninety-three percent of these specimens are actually used, whereas 7% of them have a potential use.

(b) Utilized by

A disappointing 8 702 specimens have a utilized by code. Forty-six percent of these specimens are utilized by man while stock utilizes 27% of the specimens (Fig. 17). Relatively high percentages of specimens are utilized by man in Swaziland (63%), Botswana (68%) and Lesotho (68%). Stock utilizes 41% of the

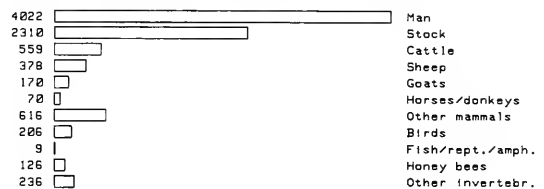


FIG. 17.—Distribution of specimens by utilized by code.

TABLE 2.—Distribution of specimens by veld type and province. See text for further explanation

VELD TYPE	Number of specimens					Specimens/100 square km				
	Cape	Tvl	OFS	Natal	Total	Cape	Tvl	OFS	Natal	Total
I COASTAL TROPICAL FOREST TYPES										
1 Coastal Forest and Thornveld	267	0	0	349	616	5.23	.00	.00	2.33	3.07
2 Alexandria Forest	5	0	0	0	5	.25	.00	.00	.00	.25
3 Pondoland Coastal Plateau Sourveld	27	0	0	14	41	4.31	.00	.00	13.46	5.62
4 Knysna Forest	26	0	0	0	26	.69	.00	.00	.00	.69
5 'Ngongoni Veld	30	0	0	117	147	1.13	.00	.00	1.38	1.32
6 Zululand Thornveld	0	3	0	9	12	.00	1.91	.00	.28	.35
7 Eastern Province Thornveld	36	0	0	0	36	.58	.00	.00	.00	.58
II INLAND TROPICAL FOREST TYPES										
8 North-eastern Mountain Sourveld	0	14	0	1	15	.00	.16	.00	.16	.16
9 Lowveld Sour Bushveld	0	66	0	0	66	.00	.59	.00	.00	.59
III TROPICAL BUSH AND SAVANNA TYPES (BUSHVELD)										
10 Lowveld	0	434	0	17	451	.00	5.91	.00	.15	2.41
11 Arid Lowveld	0	0	0	0	0	.00	.00	.00	.00	.00
12 Springbok Flats Turf Thornveld	0	4	0	0	4	.00	.12	.00	.00	.12
13 Other Turf Thornveld	0	0	0	0	0	.00	.00	.00	.00	.00
14 Arid Sweet Bushveld	0	254	0	0	254	.00	1.34	.00	.00	1.34
15 Mopani Veld	0	727	0	0	727	.00	3.51	.00	.00	3.51
16 Kalahari Thornveld and Shrub Bushveld	26	5	1	0	32	.02	.07	.01	.00	.02
17 Kalahari Thornveld invaded by Karoo	5	0	0	0	5	.03	.00	.00	.00	.03
18 Mixed Bushveld	0	518	0	0	518	.00	1.20	.00	.00	1.20
19 Sourish Mixed Bushveld	3	78	0	0	81	.08	.26	.00	.00	.24
20 Sour Bushveld	0	276	0	0	276	.00	1.51	.00	.00	1.51
IIIIa FALSE BUSHVELD TYPES										
21 False Thornveld of Eastern Cape	26	0	0	0	26	1.09	.00	.00	.00	1.09
22 Invasion of Grassveld by Thorn	2	0	0	0	2	.04	.00	.00	.00	.04
IV KAROO AND KARROID TYPES										
23 Valley Bushveld	324	0	0	70	394	2.03	.00	.00	.84	1.62
24 Noorsveld	15	0	0	0	15	.55	.00	.00	.00	.55

(Continued overleaf)

VELD TYPE	Number of specimens					Specimens/100 square km				
	Cape	Tvl	OFS	Natal	Total	Cape	Tvl	OFS	Natal	Total
25 Succulent Mountain Scrub (Spekboomveld)	133	0	0	0	133	1.52	.00	.00	.00	1.52
26 Karroid Broken Veld	232	0	0	0	232	.69	.00	.00	.00	.69
27 Central Upper Karoo	62	0	0	0	62	.32	.00	.00	.00	.31
28 Western Mountain Karoo	389	0	0	0	389	1.97	.00	.00	.00	1.97
29 Arid Karoo	84	0	0	0	84	.12	.00	.00	.00	.12
30 Central Lower Karoo	29	0	0	0	29	.29	.00	.00	.00	.29
31 Succulent Karoo	215	0	0	0	215	.65	.00	.00	.00	.65
32 Orange River Broken Veld	128	0	0	0	128	.38	.00	.00	.00	.38
33 Namaqualand Broken Veld	478	0	0	0	478	1.68	.00	.00	.00	1.68
34 Strandveld of West Coast	339	0	0	0	339	5.37	.00	.00	.00	5.37
IVa FALSE KAROO TYPES										
35 False Arid Karoo	34	0	0	0	34	.27	.00	.00	.00	.27
36 False Upper Karoo	377	0	61	0	438	.97	.00	.23	.00	.67
37 False Karroid Broken Veld	72	0	0	0	72	.77	.00	.00	.00	.77
38 False Central Lower Karoo	11	0	0	0	11	.82	.00	.00	.00	.82
39 False Succulent Karoo	10	0	0	0	10	.09	.00	.00	.00	.09
40 False Orange River Broken Veld	8	0	3	0	11	.15	.00	1.51	.00	.20
41 Pan Turf Veld invaded by Karoo	0	0	1	0	1	.00	.00	.09	.00	.09
42 <i>Merxmüllera</i> Mountain Veld replaced by Karoo	33	0	0	0	33	1.63	.00	.00	.00	1.63
43 Mountain Renosterbosveld	510	0	0	0	510	4.56	.00	.00	.00	4.56
V TEMPERATE AND TRANSITIONAL FOREST AND SCRUB TYPES										
44 Highland Sourveld and Dohne Sourveld	182	0	36	210	428	.74	.00	.99	1.88	1.08
45 'Ngongoni Veld of Natal Mist Belt	0	0	0	17	17	.00	.00	.00	.46	.46
46 Coastal Renosterbosveld	744	0	0	0	744	5.10	.00	.00	.00	5.10
47 Coastal Macchia	898	0	0	0	898	10.72	.00	.00	.00	10.72
VI PURE GRASSVELD TYPES										
48 <i>Cymbopogon-Themeda</i> Veld (sandy)	5	9	23	0	37	.16	.06	.10	.00	.09
49 Transitional <i>Cymbopogon-Themeda</i> Veld	0	0	13	0	13	.00	.00	.09	.00	.09
50 Dry <i>Cymbopogon-Themeda</i> Veld	20	27	24	0	71	.55	.19	.09	.00	.16
51 Pan Turf Veld of Western Free State	0	0	4	0	4	.00	.00	.15	.00	.15
52 <i>Themeda</i> Veld (Turf Highveld)	0	95	0	0	95	.00	.87	.00	.00	.87
53 <i>Themeda</i> Veld to <i>Cymbopogon-Themeda</i> Veld Transition	0	54	41	0	95	.00	12.89	.36	.00	.81
54 <i>Themeda</i> Veld to Highland Sourveld Transition	0	0	4	25	29	.00	.00	.67	48.08	1.05
55 <i>Themeda</i> Veld to Bankenveld Transition	0	6	0	0	6	.00	.88	.00	.00	.88
56 Highland Sourveld to <i>Cymbopogon-Themeda</i> Veld	21	0	16	20	57	.87	.00	.22	19.23	.58
57 North-eastern Sandy Highveld	0	1	0	0	1	.00	.01	.00	.00	.01
58 <i>Themeda-Festuca</i> Alpine Veld	7	0	0	10	17	.10	.00	.00	1.01	.21
59 Stormberg Plateau Sweetveld	16	0	0	0	16	.65	.00	.00	.00	.65
60 Karroid <i>Merxmüllera</i> Mountain Veld	247	0	0	0	247	1.73	.00	.00	.00	1.73
VIIa FALSE GRASSVELD TYPES										
61 Bankenveld	0	314	4	0	318	.00	1.37	.62	.00	1.35
62 Bankenveld to Sour Sandveld Transition	0	11	0	0	11	.00	.95	.00	.00	.95
63 Piet Retief Sourveld	0	7	0	0	7	.00	.11	.00	.00	.09
64 Northern Tall Grassveld	0	0	0	0	0	.00	.00	.00	.00	.00
65 Southern Tall Grassveld	0	0	0	5	5	.00	.00	.00	.04	.04
66 Natal Sour Sandveld	0	0	0	5	5	.00	.00	.00	.09	.09
67 Pietersburg Plateau Grassveld	0	0	0	0	0	.00	.00	.00	.00	.00
68 Eastern Province Grassveld	27	0	0	0	27	4.50	.00	.00	.00	4.50
VII SCLEROPHYLLOUS BUSH TYPES										
69 Macchia (Fynbos)	4 270	0	0	0	4270	23.93	.00	.00	.00	23.93
VIIa FALSE SCLEROPHYLLOUS BUSH TYPES										
70 False Macchia	640	0	0	0	640	3.58	.00	.00	.00	3.58

specimens in the Cape Province and 61% in the Orange Free State in comparison with the 29% and 13% which are utilized by man in the Cape and Orange Free State respectively.

(c) Economic property

Only 1% of the specimens have an economic property code, of which 59% are stated as being eaten (Fig. 18). Other economic properties which occurred with a frequency of more than 5% were poison (7%), general medicine (13%) and structural purposes (6%). Another 78 specimens are used for magic or ritual purposes, 121 specimens are used as beverage, 80 as fuel, 74 as sand binders, 61 as ground covers and 216 as ornamental plants in gardens.

Thirty-six percent of the specimens with economic property codes in Lesotho are used as medicine com-

pared with 34% which are used as food. In Swaziland a relatively high 14% of the specimens are used for structural purposes.

Examples of the specimens which have magic as an economic property are listed in Table 3. From an examination of the entire set of specimens with this code it is clear that such attributes are given to plants from diverse taxa but that relatively few collectors regularly noted such attributes. Most specimens with this property were collected by J. Gerstner (Natal) and W. G. Barnard (Transvaal).

(d) Special record

A special record code was used to indicate plants collected for a specific purpose or survey. A total of 9 288 specimens have such a code. Of these, 34% are for SKF alkaloid studies, 25% for anatomy studies, 19% for a cancer research project, 9% for pollen studies (UOFS) and 5% for the 'Stijfsiekte' survey.

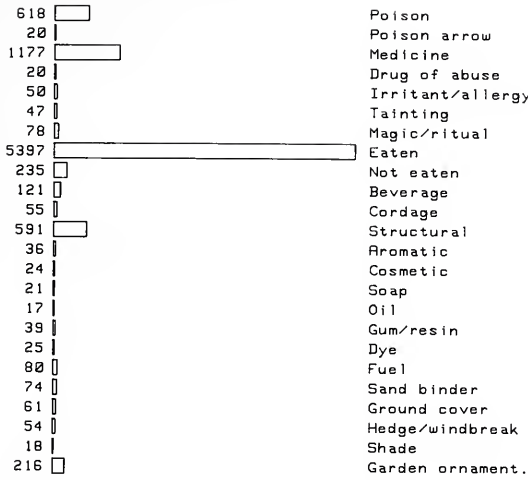


FIG. 18.—Distribution of specimens by economic property code.

PHENOLOGY

It is likely that phenological studies, i.e. the relationships between climatic factors and periodic phenomena in organisms (Daubenmire, 1959), will be facilitated in future through the use of PRÉCIS. Many plants, as an example of phenology, are known to flower in response to some change in the environment (Salisbury, 1963). It is possible to find all the specimens of a particular species that were either flowering or fruiting at the time of collection (from the state of the specimen codes) and to sort these by month of collection (and day, if necessary) in order to study the march of phenological development over a large geographic range.

To illustrate our contention that PRÉCIS can be of use in this way, the flowering patterns of three widespread indigenous grass species were obtained. Printouts were made of all specimens, from South Africa only, with flowers present or mature, sorted by month and day of collection. With the aid of these printouts as well as computer-generated distribution

TABLE 3.—Examples of specimens coded with 'magic' economic property code

Name	Use—as described on label	Region	Surname of collector	Year
<i>Kyllinga erecta</i> K. Schum. var. <i>intricata</i> C.B.Cl.	Used by doctor himself before throwing bones	Botswana	Curson	—
<i>Tulbaghia natalensis</i> Bak.	Planted by natives before hut doors to ward off snakes	Natal	Gerstner	1939
<i>Asparagus buchananii</i> Bak.	Used for calling the rain	Transvaal	Barnard	1935
<i>Celtis africana</i> Burm. f.	Magical stick placed across footpath	Transvaal	Barnard	1934
<i>Silene bellidioides</i> Sond.	Love charm	Natal	Gerstner	1943
<i>Cadaba termitaria</i> N.E.Br.	Natives believe that pursuers can be warded off by carrying	Transvaal	Louw	1946
<i>Cassia floribunda</i> Cav.	Warding off snakes	Natal	Gerstner	1944
<i>Erioseina psoraleoides</i> (Lam.) G. Don	Natives burn to protect against lightning	Swaziland	Pierce	1920
<i>Trichilia emetica</i> Vahl.	Muti gatherers use bark	Natal	Edwards	1964
<i>Berchemia discolor</i> (Klotzsch) Hemsl.	Natives think they can allure with bark	Natal	Gerstner	1944
<i>Asclepias meliodora</i> Schltr.	Love charm	Natal	Gerstner	1948
<i>Withania somnifera</i> (L.) Dun.	Used by bushmen for charm purposes in lion hunting	S.W.A.	Maguire	1953
<i>Rhigozum obovatum</i> Burch.	If you have lost something, carry a stick of this and you will find the lost item	S.W.A.	Rodin	1973
<i>Gardenia spatulifolia</i> Stapf & Hutch.	Magical	Transvaal	Barnard	1934
<i>Pentanisia prunelloides</i> (Klotzsch ex Eckl. & Zeyh.) Walp.	Charm	Natal	Brandwyk	1930
<i>Vernonia mespilifolia</i> Less.	Famous love charm	Natal	Gerstner	1948
<i>Psiadia punctulata</i> (DC.) Oliver & Hiern ex Vatke	Put under pillow to prevent dreaming	Transvaal	Barnard	1934
<i>Gnaphalium luteo-album</i> L.	Use in bathing water to remove witchcraft spell	Botswana	Curson	—
<i>Senecio microglossus</i> DC.	A branch is placed beneath pillow to inhibit dreaming in sleeper thereon	Transvaal	Mogg	1936
<i>Senecio pleistocephalus</i> S. Moore	Used for medicinal and magical purposes	Transvaal	Barnard	1934

maps of those specimens with quarter degree grid references, the distributions of *Eragrostis capensis* (Fig. 19), *Themeda triandra* (Fig. 20) and *Heteropogon contortus* (Fig. 21) were drawn. All three species are widespread in the Transvaal, Orange Free State and Natal and occur along the southern Cape coast as far as Cape Town. The general distribution patterns based on the computer data base are remarkably similar to those given by Chippindall (1955) for the same species even though only about two-thirds of the specimens in the data base could be plotted (those specimens flowering at other times of year, without date of collection, collected without flowers or with localities that could not be converted to grid references were excluded). In all three species, early flowering (August to October) is clearly restricted to the eastern and southern coastlines and to a less marked extent to the midlands of Natal. Later flowering (October to February, depending on the species concerned) is found inland in the Cape and throughout the distribution ranges of the species. Where three flowering periods are plotted there is a clear progression of flowering from the coast to the interior.

It is not our intention to provide a detailed explanation for the phenomenon described above. We consider that photoperiodism (Salisbury, 1963) is unlikely to be accounting for the observed pattern, as the pattern is not directly related to latitude, and that temperature is likely to be playing a major role. It has been shown by Schulze & McGee (1978) that isotherms run parallel to the coasts of South Africa with decreasing values with distance inland, reflecting the effects of continentality. Thus we expect that the coast is warmer earlier in the growing season than the interior at a given latitude, accounting for a more rapid phenological development on the coast. Although temperatures in the far northern Transvaal are as high, if not higher, than those on, say, the Natal coast, soil moisture as an interacting factor is probably limiting growth early in the season in the Transvaal.

With the aid of PRÉCIS, the phenology of a large number of species can be investigated rapidly. In this way, it would be possible to ascertain how general the pattern found with these three grasses is, as a first step towards explaining the phenomenon in detail. From preliminary studies of this kind with tree species, *Acacia karroo* Hayne, *Erythrina lysistemon* Hutch. and *Apodytes dimidiata* E. Mey. ex Arn., it appears that not all widespread species respond to the same environmental triggers in the same way as these species appear to have synchronized flowering and fruiting throughout their range within South Africa.

DINTER'S COLLECTING ROUTE

According to Dr L. E. Codd (pers. comm.) the last route followed by Dinter, an important collector in South West Africa, is not as well known as those of his earlier visits, accounts of which he published. As an example of the use to which PRÉCIS could be put for this purpose, a printout of Dinter's specimens collected from December 1933 until he finally left the country was made with specimens sorted according to date of collection. The following reconstruction is based on that printout of specimens housed in the National Herbarium.

From December 1933 until mid-March 1934 Dinter collected extensively in the Karibib district. His specimen numbers ran from 6721 to about 7474 and com-

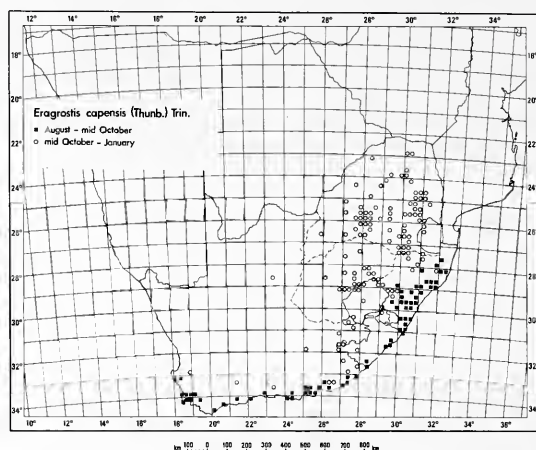


FIG. 19.—Distribution of flowering in *Eragrostis capensis* within South Africa.

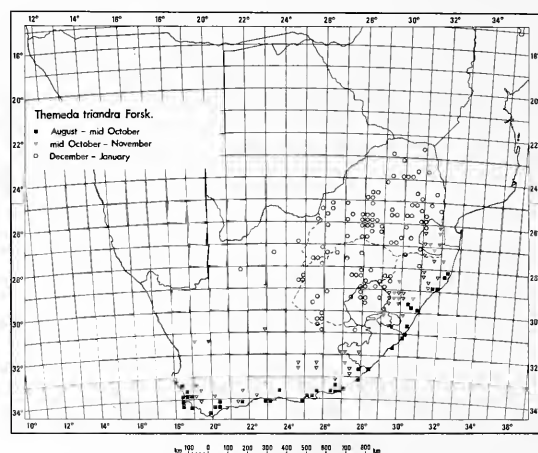


FIG. 20.—Distribution of flowering in *Themeda triandra*.

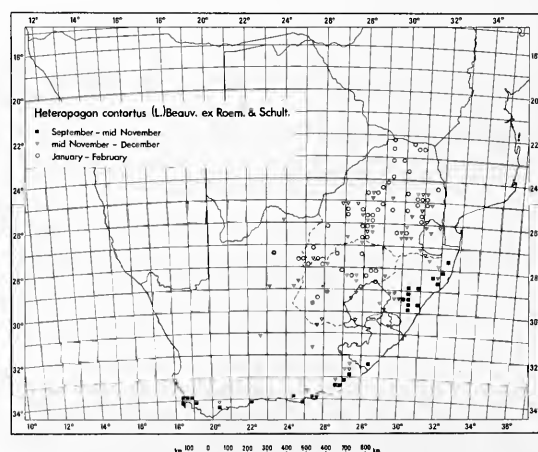


FIG. 21.—Distribution of flowering in *Heteropogon contortus*.

mon collecting localities included Kalkhugel, Kalkbuschsteppe, Okongava, Amusema, Ameib, Erongo and Unduas. In mid-March he moved north-east to Grootfontein, collecting on the way, and on the 18th March started collecting in the Tsumeb district. He remained in that area until mid-July, collecting specimens 7497 to 7703. Localities included Heidelberg, Bobos, Neitsas and Guchab. During this period he also collected occasionally at Karakowisa, east of Grootfontein. During August he returned to the Karibib district where he collected a few specimens near Okahandja. Dinter then travelled south to Windhoek where he collected specimens on the 10th October. A few days later he collected south-west of Windhoek at Lichsteinstein, Friedental, Weissenfels and in the Hakos Mountains. He stayed in this area until about the 20th December, collecting numbers 7889 to 8054. During late December he travelled further south to Buchholzbrunn, near Aus, where he collected numbers 8264 to 8307. From this area he travelled to Swakopmund, collecting specimens at Helmeringhausen and Nudaus on the way. In March 1935 he collected at Swakopmund, with the last specimen to be collected in the territory apparently being *Hypertelis caespitosa* Friedr. (no. 8471) on the 15th March 1935.

We have shown above that a fairly detailed account of a collector's route can be obtained from a study of his specimens in such a data bank. Without selection and sorting by computer, of course, and a good collection of his material in the herbarium, it would not have been feasible to undertake such a task. Other factors contributing to the success of this particular exercise were the presence of dates, sequential collecting numbers and localities that could be identified on most labels. Absence of one or more of these items would have made reconstruction far more difficult, if not impossible.

CONCLUSION

In this paper we have presented an account of what information is contained within the PRÉCIS data bank and have given two examples of the kinds of information that may be extracted from it. In some areas, e.g. economic botany and habitat information, there is far less information available on herbarium sheets than had been expected. Also, it has become clear that collectors note abnormal characteristics and situations far more regularly than normal ones, leading to an apparent bias in some categories. On the other hand, we consider that particularly valuable information has already been extracted and should continue to be extracted from PRÉCIS for the benefit of the botanical community in South Africa. Obviously, the information presented in this paper has limited value in itself but the data bank should be of particular use in revisionary studies, regional floras and biogeographic research.

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Wyk, J. Nel and Miss B. Young and all the computer programmers who have worked on this project through the Department's Computer Centre; Dr H. F. Glen and Mrs J. Jooste who were closely associated with the project during its development; Dr L. E. Codd and Miss M. D. Gunn for discussions on historical aspects; and, finally, Dr B. de Winter for continued faith in and encouragement with this project.

UITTREKSEL

*Die inhoud van die gerekenariseerde inligting berging en onttrekking stelsel (PRÉCIS) van die Nasionale Herbarium, Pretoria (PRE) word breedvoerig bespreek, hoofsaaklik by wyse van frekwensie histogramme van beskrywingskodes. Die frekwensie verspreidings wat gevind is, word in die lig van die geskiedenis van die herbarium, die geografie van die gebied en die gewoontes van plantversamelaars bespreek. Twee gebruike van PRÉCIS word deur voorbeelde geïllustreer. Eerstens, word die blouffnologie van *Eragrostis capensis*, Themeda triandra en *Heteropogon contortus* geplot en, tweedens, word die roete wat deur Dinter in Suidwes-Afrika vanaf Desember 1933 tot Maart 1935 gevolg is, beskryf. Daar is tot die gevolgtrekking gekom dat die stelsel van besondere nut in hersienings studies, streeks floras en biogeografiese navorsing kan wees.*

REFERENCES

- ACOCKS, J. P. H., 1975. Veld types of South Africa. 2nd edn. *Mém. bot. Surv. S. Afr.* No. 40.
- CHIPPINDALL, L. K. A., 1955. A guide to the identification of grasses in South Africa. In D. Meredith, *The grasses and pastures of South Africa*. Johannesburg: CNA.
- CROVELLO, T. J. 1972. Computerization of specimen data from the Edward Lee Greene Herbarium (ND-G) at Notre Dame. *Brittonia* 24: 131-141.
- DAUBENMIRE, R. F., 1959. *Plants and environment*. New York: John Wiley.
- DYER, R. A., 1977. Botanical research in South Africa in the twentieth century. In A. C. Brown, *A history of scientific endeavour in South Africa* 240-264. Cape Town: Royal Society of South Africa.
- EDWARDS, D. 1974. Survey to determine the adequacy of existing conserved areas in relation to vegetation types. A preliminary report. *Koedoe* 17: 2-37.
- EDWARDS, D. & LEISTNER, O. A., 1971. A degree reference system for citing biological records in Southern Africa. *Mitt. bot. StSamml., Münch.* 10: 501-509.
- MORRIS, J. W., 1974. Progress in the computerization of herbarium procedures. *Bothalia* 11: 349-353.
- MORRIS, J. W., 1980. Encoding the National Herbarium (PRE) for computerised information retrieval. *Bothalia* 13: 149-160.
- MORRIS, J. W. & GLEN, H. F., 1978. PRÉCIS, the National Herbarium of South Africa (PRE) computerised information system. *Taxon* 27: 449-462.
- MORRIS, J. W. & LEISTNER, O. A., 1975. Progress with computerization of the National Herbarium, Pretoria. *Boissiera* 24: 411-413.
- PHILLIPS, E. P., 1930. A brief historical sketch of the development of botanical science in South Africa and the contribution of South Africa to botany. *S. Afr. J. Sci.* 27: 39-80.
- ROSS, J. H., LEISTNER, O. A. & DE WINTER, B., 1977. *A guide to contributors to the Flora of Southern Africa (F.S.A.)*. Pretoria: Department of Agricultural Technical Services.
- SALISBURY, F. B., 1963. *The flowering process*. Oxford: Pergamon Press.
- SCHULZE, R. E. & MCGEE, O. S., 1978. Climatic indices and classification in relation to the biogeography of Southern Africa. In M. J. A. Werger, *Biogeography and ecology of Southern Africa* 19-52. The Hague: Dr W. Junk.

Leaf anatomy of the South African Danthonieae (Poaceae).

IV. *Merxmuellera drakensbergensis* and *M. stereophylla*

R. P. ELLIS*

ABSTRACT

The leaf blade anatomy of *Merxmuellera drakensbergensis* (Schweick.) Conert and *M. stereophylla* (J. G. Anders.) Conert is described and illustrated. These two closely related species have virtually identical leaf anatomy—both the leaf in section and the abaxial epidermis. The close anatomical resemblance between these two species raises doubts about their specific status. This is especially significant when compared with the considerable differences observed between the anatomical 'forms' recognized in *M. disticha* (Nees) Conert (Ellis, 1980) and *M. stricta* (Schröd.) Conert (Ellis, 1980a).

RÉSUMÉ

L'ANATOMIE DE LA FEUILLE DU DANTHONIEAE (POACEAE) SUD AFRICAIN. IV. MERXMUELLERA DRAKENSBERGENSIS ET M. STEREOPHYLLA

L'anatomie de la feuille de *Merxmuellera drakensbergensis* (Schweick.) Conert et *M. stereophylla* (J. G. Anders.) Conert est décrite et illustrée. Ces deux espèces étroitement apparentées ont une anatomie de la feuille virtuellement identique—tant la section de la feuille que l'épiderme abaxial. La ressemblance anatomique étroite entre ces deux espèces soulève des doutes au sujet de leur statut spécifique. Ceci est spécialement significatif quand on compare les différences considérables observées entre les "formes" anatomiques reconnues dans *M. disticha* (Nees) Conert (Ellis, 1980) et *M. stricta* (Schröd.) Conert (Ellis, 1980a).

INTRODUCTION

Merxmuellera drakensbergensis (Schweick.) Conert (1970) (= *Danthonia drakensbergensis* Schweick.) and *M. stereophylla* (J. G. Anders.) Conert (1970) (= *D. stereophylla* J. G. Anders.) are wiry-leaved perennials forming rigid, erect tussocks. The unbranched culms grow vertically and the leaves are rigid and taper to a pungent apex. In both species these leaves are setaceous and tightly involute or canaliculate.

These two species are conspicuous components of the alpine vegetation of the Drakensberg mountains to which they are restricted. *M. drakensbergensis* occurs in the Barkly East and Maclear Districts of the north-eastern Cape, along the Drakensberg mountains of Natal and Lesotho and at Mariepskop in the Drakensberg of the north-eastern Transvaal. *M. stereophylla* has a more limited distribution, being found only in the Drakensberg areas of Natal and Lesotho at altitudes above 2 000 m. Although the distribution of these two species overlaps in the Natal and Lesotho alpine areas, they can, nevertheless, be distinguished both ecologically and morphologically.

M. drakensbergensis occupies mesic situations in the streambank and mud patch communities (Killick, 1963; Edwards, 1967) of the alpine belt along the summit of the high Drakensberg. The habitat of *M. stereophylla*, on the other hand, is essentially xeric and this species is common in the alpine grassland of the basalt cliffs as a crevice and ledge plant. In the *Danthonia* Tussock Grassland (Edwards, 1967) *M. drakensbergensis* is dominant around sponges and mud patches, but on rocky areas *M. stereophylla* is the principal grass. Although these two closely related species (Anderson, 1960) have long been confused, they are distinct ecologically and in the field can readily be distinguished by their differing habitat requirements.**

Vegetatively, these species can also be easily recognized. *M. stereophylla* has rigid, erect, grey-green

leaves, whereas *M. drakensbergensis* has softer leaves which are olive-green in colour. *M. drakensbergensis* plants are up to 100 cm tall and *M. stereophylla* is a slightly smaller plant up to 80 cm high. A characteristic feature of *M. drakensbergensis*, which is not evident in *M. stereophylla*, concerns the behaviour of old leaf blades (Anderson, 1960). These normally break off above the ligule and the remaining portion of blade splits along the median nerve and the resultant halves recurve outwards in opposite directions. This useful field diagnostic character appears to be consistent and it is only in recently burnt plants that this character is not evident. However, as these species are badly injured by fire (Edwards, 1967) they are largely confined to fire-protected moist or rocky habitats. *M. macowanii* (Stapf) Conert also exhibits this vegetative characteristic and can, therefore, be confused with *M. drakensbergensis*. Both species are also streambank plants, but *M. macowanii* appears to be limited to the montane and sub-alpine belt below the summit of the Drakensberg.

The relatively recent description and recognition of *M. drakensbergensis* and *M. stereophylla* is somewhat surprising in view of these distinct ecological and vegetative differences. *M. drakensbergensis* was only described in 1938 (Schweikerdt, 1938), prior to which it was referred to *M. macowanii*. *M. stereophylla* received recognition as recently as 1960 (Anderson, 1960), although Chippindall (1955) mentioned an undescribed species from the high Drakensberg and was undoubtedly referring to this species. A probable reason for these species remaining undescribed for so long is the relative inaccessibility of the area in which they occur, as well as the fact that

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**According to Killick (1978) *M. drakensbergensis* is an ubiquitous species in the alpine belt of the Sani Pass area of the southern Drakensberg: it often occurs in flushes or along streambanks but is also found on rock outcrops and in Alpine Grassland, sometimes covering fairly large areas. *M. stereophylla*, on the other hand, appears to be restricted to dry outcrops at higher altitudes in this part of the Drakensberg. *M. drakensbergensis* is, therefore, not restricted to semi-aquatic communities in this area but displays a wider ecological tolerance. It, nevertheless, prefers deeper and moister soils than *M. stereophylla*.

spikelet differences are slight and only a matter of degree. Thus the arrangement of the hairs on, and the length of, the lemmas (including lobes and awns) differ slightly (Anderson, 1960, 1962).

That these two species are very closely related (Anderson, 1960) is confirmed by the anatomy of their leaf blades which is almost identical. No consistent and measurable structural differences are evident and evidence from leaf anatomy, therefore, casts some doubt on the validity of granting these species specific status. This is especially significant when compared with the situation in *M. stricta* (Schrad.) Conert (Ellis, 1980a) and *M. disticha* (Nees) Conert (Ellis, 1980) where disjunct, relatively important anatomical differences were found to occur within each of these species. These anatomical differences were found to be consistently correlated with ecological and morphological differences and, therefore, these 'forms' of *M. stricta* and *M. disticha* appear to warrant similar taxonomic treatment to *M. drakensbergensis* and *M. stereophylla*. The granting of specific status to *M. drakensbergensis* and *M. stereophylla*, therefore, requires reassessment.

The only anatomical differences observed between these two species are slight differences in size and

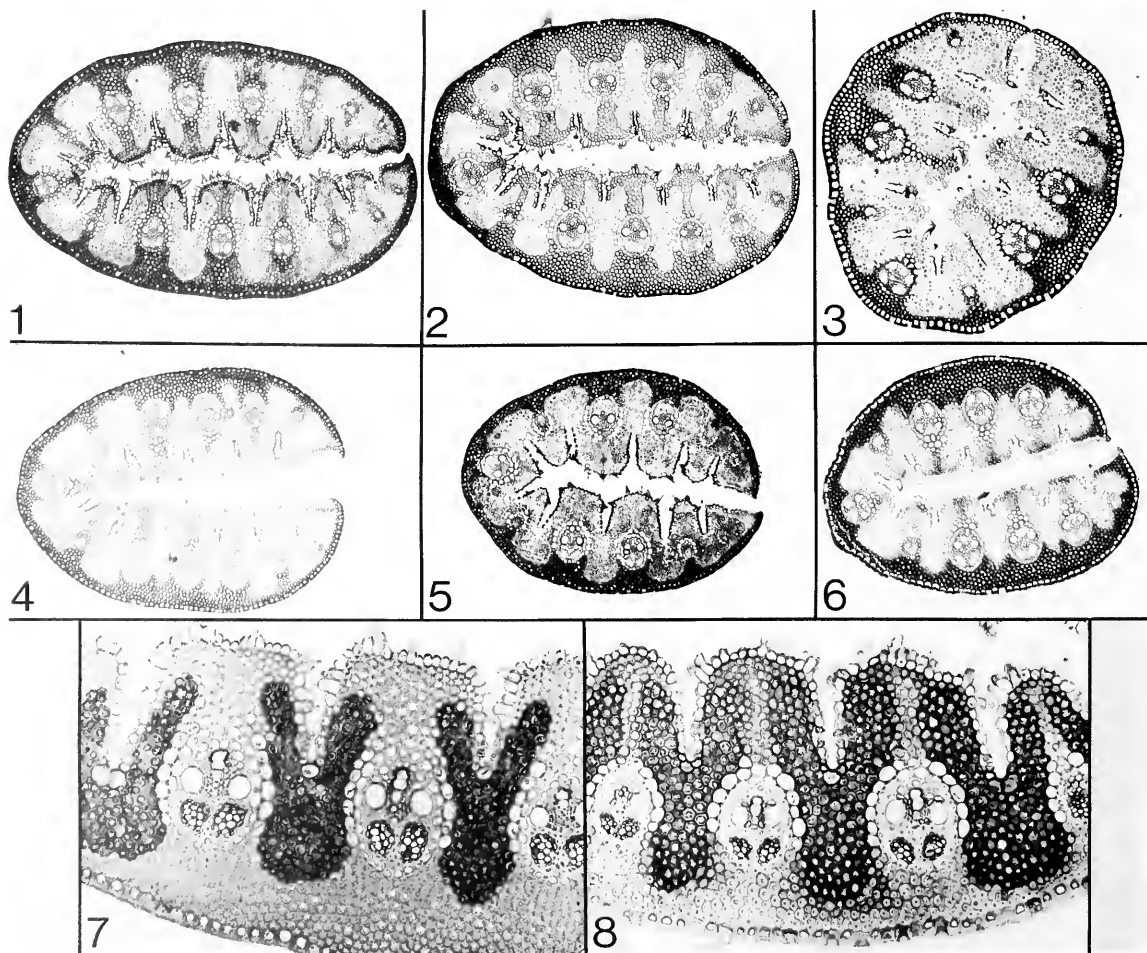
hence a combined description will suffice for both. Leaf anatomy and epidermal structure will be described following the terminology of Ellis (1976, 1979) and the following abbreviations will be used in the description:

vb/s	— vascular bundle/s
1'vb/s	— first order vascular bundle/s
2'vb/s	— second order vascular bundle/s
3'vb/s	— third order vascular bundle/s
ibs	— inner bundle sheath; mestome sheath
obs	— outer bundle sheath; parenchyma sheath

COMBINED ANATOMICAL DESCRIPTION OF
MERXMUELLERA DRAKENSBERGENSIS AND
M. STEREOPHYLLA

Leaf in transverse section

Leaf outline: permanently and tightly infolded with elliptical outline. Laminae slightly asymmetrical about the median vb such that adaxial furrows of one half of lamina align with adaxial ribs on other half of lamina. As a result margins overlap slightly. Adaxial channel always a deep, narrow cleft with a slight opening where margins overlap. *Leaf size:* setaceous; leaves narrow (0,56 mm–3,60 mm wide)



FIGS 1–8.—Leaf blade outline of *Merxmuellera drakensbergensis* and *M. stereophylla* in transverse section. 1–3, *M. drakensbergensis*, all $\times 160$. (1, Du Toit 669; 2, Liebenberg 5707; 3, Du Toit 2313.) 4–6, *M. stereophylla*, all $\times 160$. (4, Jacot Guillarmod 3733; 5, Roberts 3152; 6, Edwards 2284.) 7, *M. drakensbergensis*, $\times 400$. (Ellis 3191.) 8, *M. stereophylla*, $\times 400$. (Ellis 3139.)

but tend to be thinner in *M. stereophylla* (0.56 mm–1.13 mm wide) than in *M. drakensbergensis*. This tendency reflected in number of vbs in leaf section. 11–15 vbs present with 11 vbs always in *M. stereophylla* (Figs 4–6) and *M. drakensbergensis* usually with 13 or 15 vbs (Figs 1 & 2) but sometimes only 11 vbs present (Fig. 3). **Ribs and furrows:** medium to deep cleft-like adaxial furrows between all vbs; rounded (Fig. 8) or slightly flat-topped (Fig. 7) ribs over all vbs; one vb per rib. Abaxial surface smooth or with very slight undulations associated with vbs (Fig. 3). **Median vascular bundle:** present but indistinguishable structurally from 1'vbs. **Vascular bundle arrangement:** no 2'vbs; 3'vbs absent between consecutive lateral 1'vbs. All bundles centrally located between upper and lower epidermides. **Vascular bundle structure:** vbs circular or elliptical in shape. Xylem and phloem distinguishable in all vbs; phloem adjoins ibs; phloem divided vertically into two equal groups by intrusion of fibres (Figs 7 & 8). Metaxylem vessel diameter narrow being only slightly greater than the diameter of the obs cells; slightly thickened. **Vascular bundle sheaths:** obs of all vbs horse-shoe shaped with wide abaxial interruptions. Adaxial interruptions usually fairly narrow (Fig. 8) but may be wide (Fig. 7) especially in *M. drakensbergensis*. No bundle sheath extensions present. Obs cells round or elliptical, sometimes with straight radial walls (Fig. 8); all obs cells similar in shape but small, being only slightly larger than the mesophyll cells in cross-sectional area; cell walls slightly but distinctly thickened; without chloroplasts. Inner sheath complete around all vbs; ibs cells similar in size to the obs cells but with considerably thicker walls, especially inner tangential wall (Fig. 8). **Sclerenchyma:** adaxial girders inversely anchor-shaped with narrow (Fig. 8) or sturdy (Fig. 7) stem; fibres interrupt obs. Abaxial sclerenchyma in form of continuous subepidermal band (especially well developed adjacent lateral 1'vbs) of varying thickness with large trapezoidal girders extending to, and interrupting, the obs; girders comprised of thick-walled fibres usually lignified although fibres near margin may be of cellulose (Fig. 1). **Leaf margin:** very small, pointed, poorly developed cap. **Mesophyll:** non-radiate; chlorenchyma of regular, small, isodiametric cells; tightly packed with air spaces not visible; in

Y-shaped groups occupying sides and bases of adaxial furrows (Figs 7 & 8). No colourless cells present. **Adaxial epidermis:** poorly developed bulliform cells at bases of furrows. Macro-hairs absent. Pointed prickles with broad, but not bulbous bases; present throughout costal zones. Outer walls of epidermal cells arched and somewhat inflated and appear to be papillate. These may, however, represent sections, through varying planes, of the prickles. **Abaxial epidermis:** bulliform cells absent. Outer cell walls markedly thickened with a continuous, thick cuticle. No macro-hairs, prickles or papillae.

Abaxial epidermis in surface view

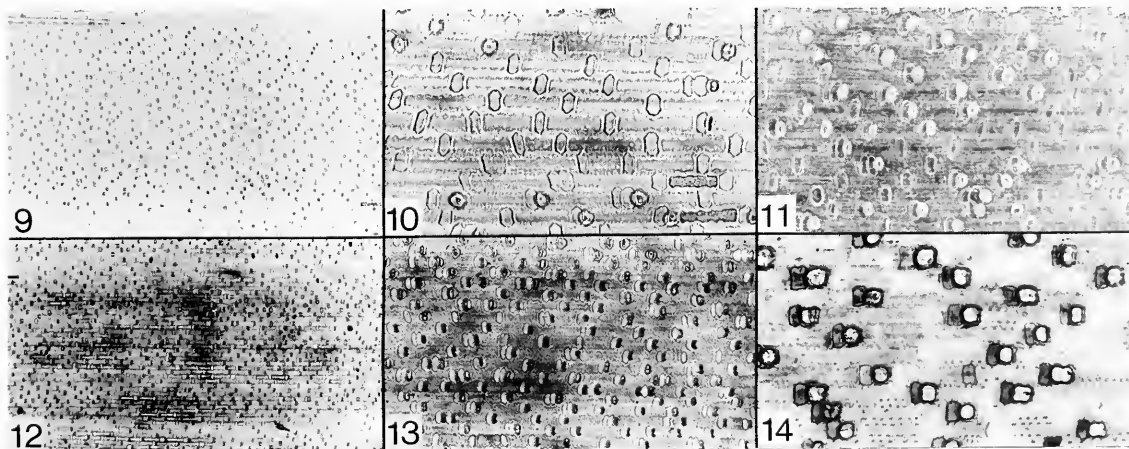
Intercostal zone: undifferentiated and entire abaxial epidermis similar in structure (Fig. 9 & 12) and essentially a costal zone due to development of continuous sub-epidermal fibrous layer. **Stomata:** absent from abaxial surface. **Prickle-hairs:** hooks and prickles not present. **Micro-hairs:** not seen on any of the specimens examined. **Macro-hairs:** absent. **Silica bodies:** equidimensional in surface view; either cuboid (Fig. 14), round (Fig. 10) or somewhat elliptical (Fig. 11); usually fitting into concavity in closely associated cork cell. Granules present; cracks sometimes present (Fig. 14). Width of silica bodies slightly narrower than costal long cells and cork cells. Similar silica bodies present throughout abaxial epidermis. **Costal cells:** silica cells and cork cells alternate with single costal long cells throughout abaxial epidermis; all files of similar cell arrangement. Silica may be relatively sparse (Fig. 10) with many silico-suberose couples actually consisting of a pair of cells (a cork and a silica cell) or even only a single cork or silica cell. Costal long cells elongated horizontally; at least 3× longer than wide; sides parallel; anticlinal walls heavily thickened and usually pitted (Fig. 10 & 13); undulations moderate to deep but difficult to distinguish clearly due to excessive cuticle thickening.

Specimens examined:

M. drakensbergensis

O.F.S.—2828 (Bethlehem): Witsieshoek-Mont-aux-Sources area (—DB), Ellis 3137, 3138, 3154, 3155, 3156.

NATAL.—2828 (Bethlehem): Sentinel (—DB), Du Toit 669, 2829 (Harrismith): Cathedral Peak Forest Reserve (—CC), Ellis 1398,



FIGS 9–14.—Abaxial epidermis of *Merxnuellera drakensbergensis* and *M. stereophylla*. 9–11, *M. drakensbergensis*. (9, Killick & Marais 2183, ×160; 10, Ellis 1398, ×640, note number of cork cells associated with silica bodies; 11, Staples 242, ×160, phase contrast.) 12–14, *M. stereophylla*. (12, Ellis 3139, ×160; 13, Ellis 3139, ×400; 14, Killick & Vahrmeijer 4019, ×640.)

3189, 3190, 3191, 3304. 2929 (Underberg): Sani Pass (—CB), *Du Toit* 2313.

LESOTHO.—2828 (Bethlehem): Maluti Mts (—CC), *Staples* 242. 2929 (Underberg): Pone Valley (—AC), *Coetsee* 824; Mokhotlong, *Liebenberg* 5707; Sani Pass summit (—CA), *Du Toit* 2209.

CAPE.—3028 (Matatiele): Naudes Nek (—CA), *Werdermann* & *Oberdieck* 1139.

M. stereophylla

O.F.S.—2828 (Bethlehem): Golden Gate National Park (—DA), *Roberts* 3152; Witsieshoek-Mont-aux-Sources area (—DB), *Ellis* 3139.

NATAL.—2828 (Bethlehem): Mont-aux-Sources (—DD), *Schelpel* 1390. 2829 (Harrismith): Cathedral Peak Forest Reserve (—CC), *Ellis* 1397, 1408, 3180, 3186, 3298, 3307, *Killick* 1317. 2929 (Underberg): Giants Castle Game Reserve (—AB), *Killick* & *Vahrneijer* 4019, *Edwards* 2284.

LESOTHO.—2828 (Bethlehem): Letseng-la-Terai (—CA), *Loxton* & *Ellis* 997. 2829 (Harrismith): Cleft Peak area (—CC), *Killick* & *Marais* 1883. 2929 (Underberg): Sani Pass summit (—CA), *Du Toit* 2208; Tschlanyane Valley (—CD), *Jacot Guillarmod* 3733.

DISCUSSION AND CONCLUSIONS

From the above anatomical description of the leaf blades of *M. drakensbergensis* and *M. stereophylla*, and from the accompanying photomicrographs (Figs 1–14), it is clearly evident that the structure of these two species is remarkably similar—both the leaf sections and the epidermis. The only difference detected in this study is a small variation in the cross-sectional area and width of the leaf sections. The magnifications of Figs. 1–6 are identical and a comparison of *M. drakensbergensis* leaf blades (Figs 1–3) with those of *M. stereophylla* (Figs 4–6) reveals that the leaves of *M. drakensbergensis* have a tendency to be larger. This difference is not consistent as numerous intermediates occur. Nevertheless this size difference is correlated with the number of vascular bundles present in the leaf blade. *M. stereophylla* has 11 vascular bundles, whereas *M. drakensbergensis* has 13 or 15. However, even this distinction is not consistent e.g. Fig. 4 which is intermediate with 12 vascular bundles and Fig. 3, *M. drakensbergensis*, with only 10 vascular bundles.

These slight quantitative differences are, nevertheless, characteristic and consistent for the majority of the specimens examined in this study. However, in this representative and extensive sample there were several specimens which proved difficult to identify satisfactorily using Anderson's (1962) key. For example, both *Ellis* 1397 and *Loxton* & *Ellis* 997 were initially determined as being *M. stricta* but, on checking, were identified as *M. drakensbergensis* and finally placed in *M. stereophylla*, mainly because they do not exhibit the outward recurving of the old leaf blades. In these specimens the arrangement of the hairs on the lemmas is apparently atypical. *Edwards* 2284 is another specimen which has caused problems with identification. Anderson and Conert both determined this specimen as being *M. aureocephala* (J. G. Anders.) Conert, but in this study it has been classified as being *M. stereophylla*.

In these morphologically atypical specimens the number of vascular bundles in the leaf section, and the corresponding width of the leaf blade, appear to be of no assistance in identification. Thus, *Ellis* 1397, collected in saturated, spongy ground is probably ecologically best placed in *M. drakensbergensis*, although it would be a very small, atypical specimen. It has only 11 vascular bundles in the leaf section, which is characteristic of *M. stereophylla*. The

ecological, morphological and anatomical indications are, therefore, in conflict.

Ellis 1397 and 1408 are specimens collected near or at the summit of the Drakensberg escarpment at Cathedral Peak. The *Merxmüllera* populations at this particular locality were characterized by being extremely variable morphologically. Anatomical studies of the *M. stricta* and *M. disticha* (*Ellis*, 1980, 1980a) specimens from this locality revealed that the various specimens actually belonged to different 'forms' with distinct anatomical, morphological and ecological characteristics and that it was mere coincidence that they were found growing in such close proximity. The *M. drakensbergensis* and *M. stereophylla* specimens from these populations, on the other hand, show no correlation between morphological, anatomical and ecological characteristics and *Ellis* 1397 and 1408 in fact represent true intermediates.

This observation, together with the close resemblance of the leaf anatomy of these two species, indicates that *M. stereophylla* and *M. drakensbergensis* are very closely related, more so, in fact, than the anatomical forms of *M. stricta* and *M. disticha*. The specific status of *M. stereophylla* and *M. drakensbergensis* is, therefore, questioned and indications are that these two taxa warrant similar taxonomic treatment to the anatomical forms of *M. stricta* and *M. disticha*.

Both *M. drakensbergensis* and *M. stereophylla* exhibit the same type of arrangement of vascular bundles along the width of the lamina, there being no third order vascular bundles between the lateral first order bundles. This is essentially similar to the position described in *M. stricta* (*Ellis*, 1980a) and indicates the relationship of *M. stricta* to *M. stereophylla* and *M. drakensbergensis*. In addition, the anatomical evidence indicates that *M. stereophylla* and *M. drakensbergensis* exhibit a similar degree of divergence from the typical *M. stricta* anatomical form as do the other three anatomical forms of *M. stricta* (*Ellis*, 1980a). This implies that consideration should be given to the granting of equivalent taxonomic status to *M. drakensbergensis*, *M. stereophylla*, typical *M. stricta* and to the three other forms of *M. stricta*. The evidence gained in the present study indicates that subspecific rank is probably justified for each of the above entities of the *M. stricta* group.

M. drakensbergensis and *M. stereophylla* are thought to be related to three other species of *Merxmüllera*, all of which also occur in the Drakensberg mountains. These are *M. macowanii* (Stapf) Conert, *M. davyi* (C. E. Hubb.) Conert and *M. aureocephala* (J. G. Anders.) Conert and together these five species form a more or less distinct and closely related group within the genus (Anderson, 1962). This is not confirmed by anatomy, however, which indicates a relationship between *M. disticha* and *M. macowanii* and *M. davyi*. This is based on the alternating arrangement of lateral first order bundles with third order vascular bundles common to the latter three species (and probably to *M. aureocephala*) (*Ellis*, in press). A similar relationship exists between *M. disticha* and *M. macowanii* and *M. davyi* to that demonstrated between *M. stricta* and *M. drakensbergensis* and *M. stereophylla*. Indications are, once again, that similar patterns of adaptive radiation have occurred in the Drakensberg area from parental stock of both *M. stricta* and *M. disticha*. Thus, in both groups, cave sandstone and

basalt, alpine bog, and streambank 'forms' appear to have evolved in response to the environmental conditions presently prevailing in the Drakensberg mountains. This unique situation will undoubtedly reward further population and cytogenetical studies.

ACKNOWLEDGEMENTS

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UITTREKSEL

Die anatomiese struktuur, van die blaas in dwarsnee en die abaksiale epidermis, van Merxmüllera drakensbergensis (Schweick.) Conert en M. stereophylla (J. G. Anders.) Conert word beskryf en geïllustreer. Hierdie twee naverwante spesies is feitlik onuitkenbaar op anatomiese kenmerke alhoewel hulle 'n sekere mate van ekologiese en morfologiese skeiding toon. Die sterk anatomiese ooreenkomstigheid tussen hierdie twee spesies bevestig die spesifieke status veral wanneer vergelykings getref word met die aansienlike anatomiese verskille wat in M. stricta

(Schröd.) Conert (Ellis, 1980a) en M. disticha (Nees) Conert (Ellis, 1980) waargeneem is.

REFERENCES

- ANDERSON, J. G., 1960. Notes and new records of African plants: Gramineae. *Bothalia* 7: 419–420.
- ANDERSON, J. G., 1962. Notes and new records of African plants: Gramineae. *Bothalia* 8: 170–172.
- CHIPPINDALL, L. K. A., 1955. In D. Meredith, *The grasses and pastures of South Africa*. Johannesburg: CNA.
- CONERT, H. J., 1970. *Merxmüllera*, eine neue Gattung der Gramineen. *Senckenberg. Biol.* 51: 129–133.
- EDWARDS, D., 1967. A plant ecology survey of the Tugela River Basin, Natal. *Mem. bot. Surv. S. Afr.* 36: 1–285.
- ELLIS, R. P., 1976. A procedure for standardizing comparative leaf anatomy in the Poaceae. I. The leaf blade as viewed in transverse section. *Bothalia* 12: 65–109.
- ELLIS, R. P., 1979. A procedure for standardizing comparative leaf anatomy in the Poaceae. II. The epidermis as seen in surface view. *Bothalia* 12: 641–672.
- ELLIS, R. P., 1980. Leaf anatomy of the South African Danthonieae (Poaceae). II. *Merxmüllera disticha*. *Bothalia* 13: 185–189.
- ELLIS, R. P., 1980a. Leaf anatomy of the South African Danthonieae (Poaceae). III. *Merxmüllera stricta*. *Bothalia* 13: 191–198.
- KILLICK, D. J. B., 1963. An account of the plant ecology of the Cathedral Peak area of the Natal Drakensberg. *Mem. bot. Surv. S. Afr.* 34: 1–178.
- KILLICK, D. J. B., 1978. Notes on the vegetation of the Sani Pass area of the southern Drakensberg. *Bothalia* 12: 537–542.
- SCHWEICKERDT, H. G., 1938. Descriptions of, and notes on, South African grasses. *Feddes Reprint* 43: 88–92.

Leaf anatomy of the South African Danthonieae (Poaceae). V. *Merxmüllera macowanii*, *M. davyi* and *M. aureocephala*

R. P. ELLIS*

ABSTRACT

Transverse sections and abaxial epidermal scrapes, of herbarium and freshly fixed leaf blade material, of *Merxmüllera macowanii* (Stapf) Conert, *M. davyi* (C. E. Hubb.) Conert and *M. aureocephala* (J. G. Anders.) Conert, were examined using light microscopy. The leaf anatomy of these three species is very similar in all respects with the exception of certain *M. aureocephala* specimens. In addition, the anatomy indicates a relationship between these three species and *M. disticha* (Nees) Conert. This group of species differs anatomically from *M. stricta* (Schrad.) Nees, and related species such as *M. drakensbergensis* (Schweick.) Conert and *M. stereophylla* (J. G. Anders.) Conert, in the sequence of vascular bundles along the width of the leaf blade and associated characters. However, the *M. aureocephala* specimens, not having the *M. disticha* type of vascular bundle arrangement, anatomically resemble the *M. stricta* group of species, and *M. aureocephala* appears to be intermediate between these two species groups.

RÉSUMÉ

L'ANATOMIE DE LA FEUILLE DU DANTHONIEAE (POACEAE) SUD AFRICAINE. V. MERXMÜELLERA MACOWANII, M. DAVYI ET M. AUREOCEPHALA

Des sections transversales et des grattages épidermiques abaxiaux, d'herbarium et de matériel de feuille fraîchement fixée, de *Merxmüllera macowanii* (Stapf) Conert, *M. davyi* (C. E. Hubb.) Conert et *M. aureocephala* (J. G. Anders.) Conert, ont été examinées en utilisant la microscopie lumineuse. L'anatomie de la feuille de ces trois espèces est très similaire dans tous les domaines à l'exception de certains spécimens de *M. aureocephala*. De plus, l'anatomie indique une relation entre ces trois espèces et *M. disticha* (Nees) Conert. Ce groupe d'espèces diffère anatomiquement de *M. stricta* (Schrad.) Nees, et des espèces apparentées telles que *M. drakensbergensis* (Schweick.) Conert et *M. stereophylla* (J. G. Anders.) Conert, dans la succession des faisceaux vasculaires le long de la largeur de la feuille et des caractères associés. Cependant, les spécimens de *M. aureocephala*, n'ayant pas le type d'arrangement de faisceaux vasculaires de *M. disticha* ressemblent anatomiquement au groupe d'espèces *M. disticha* et *M. aureocephala* apparaît être intermédiaire entre ces deux groupes d'espèces.

INTRODUCTION

Merxmüllera macowanii (Stapf) Conert (= *Danthonia macowanii* Stapf), *M. davyi* (C. E. Hubb.) Conert (= *D. davyi* C. E. Hubb.), and *M. aureocephala* (J. G. Anders.) Conert (= *D. aureocephala* J. G. Anders.) (Conert, 1970) are all wiry, tufted, tussock-forming, perennial grasses. *M. macowanii*, in particular, forms large, lax tussocks up to 60 cm in diameter with leaves up to 100 cm long arching outwards from the tuft base. *M. macowanii* and *M. davyi* are summer-flowering, whereas *M. aureocephala* is a winter-flowering species.

These three species occur in mountain vegetation along the eastern escarpment of southern Africa. *M. davyi* is found at altitudes above 2 000 m on Mt Mlanje in Malawi, the Inyanga mountains of Zimbabwe and Mariepskop in the eastern Transvaal Drakensberg (Conert, 1975). *M. macowanii* occurs from the Transvaal Drakensberg southwards as far as the Witteberge, Stormberge and Amatole Mountains of the eastern Cape. It occurs between 1 500 and 3 000 m and is also found in the midlands of Natal. *M. aureocephala* appears to be localized and restricted to the high Drakensberg of Natal in the Cathedral and Cathkin Peak areas.

M. macowanii is frequently dominant along streambanks and in marshy areas of the montane and subalpine belts of the Drakensberg (Killick, 1963; Edwards, 1967) but is, nevertheless, a xeromorphic grass with sclerophyllous leaves. *M. davyi* and *M. aureocephala*, on the other hand, prefer more xeric habitats and occur on steep grassy slopes and in rocky situations in mountain grassveld (Anderson, 1962).

These habitat preferences bear striking resemblances to the niches occupied by *M. drakensbergensis* (Schweick.) Conert and *M. stereophylla* (J. G. Anders.) Conert (Ellis, 1981). Furthermore, *M. macowanii* and *M. drakensbergensis*, both of which occupy mesic streambank and seepage habitats, display vegetative similarities in that the old leaf blades break off a short distance above the ligule, split along the mid-vein and then recurve outwards (Chippindall, 1955; Anderson, 1960). The above five species are considered to form a more or less closely related group within the genus (Anderson, 1962) and, therefore these ecological and morphological parallels are not unexpected.

The present study examined these relationships anatomically and indications are that two groups actually exist within these five species. *M. drakensbergensis* and *M. stereophylla*, therefore, display more anatomical similarities with each other than with either *M. macowanii* or *M. davyi*. It is significant that this anatomical sub-division separates species occupying similar niches and exhibiting similar old leaf blade behaviour. *M. aureocephala* specimens appear to be somewhat intermediate anatomically and possibly form a link between these two groups.

M. macowanii, *M. davyi* and *M. aureocephala* resemble one another anatomically, and, therefore, a combined description of their leaf blade anatomy will suffice. The terminology of Ellis (1976, 1979) will be used in the description with the following abbreviations:

vb/s	— vascular bundle/s
1 st vb/s	— first order vascular bundle/s
2 nd vb/s	— second order vascular bundle/s
3 rd vb/s	— third order vascular bundle/s
ibs	— inner bundle sheath; mestome sheath
obs	— outer bundle sheath; parenchyma sheath

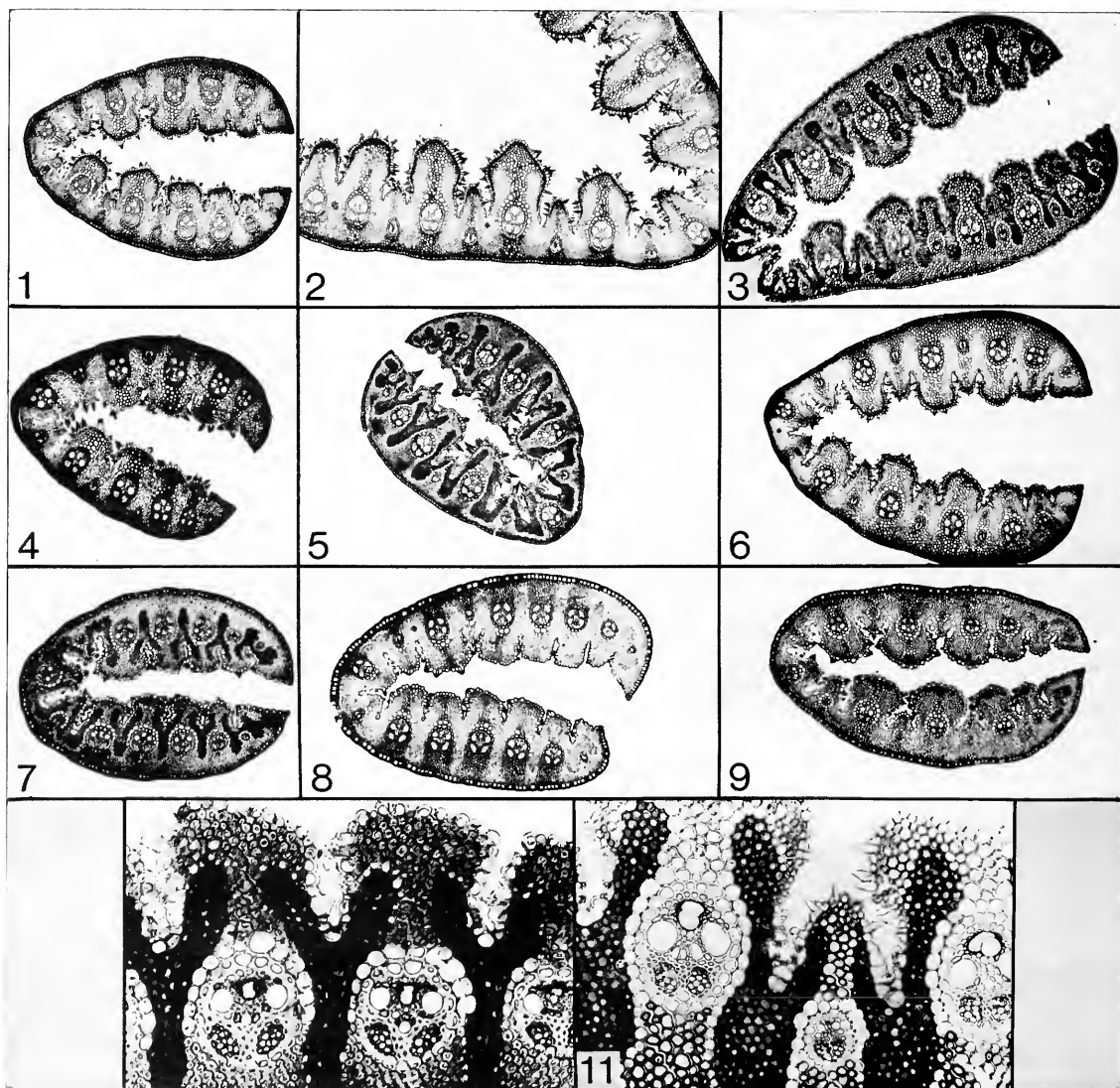
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COMBINED ANATOMICAL DESCRIPTION OF
MERXMUELLERA MACOWANII, M. DAVYI AND
M. AUREOCEPHALA

Leaf in transverse section

Leaf outline: infolded with reduced U- or V-shaped outline; opening to at least 45° possible (Fig. 2) except in certain *M. aureocephala* specimens which are permanently infolded with elliptical outlines (Figs 7 & 8). Adaxial channel deep and either cleft-like or variable depending on degree of infolding prevailing. Lamina always assymetrical about the median vb; 1'vbs of opposite halves of lamina alternate and an extra 3'vb is usually present in one half e.g. four 3'vbs in the lower half and three in the upper half of Fig. 1. This assymetry occurs in all specimens except typical *M. davyi* specimens (Figs 4 & 5). *Leaf size:* the total number of vbs in the leaf

section varies from 13–17 in *M. aureocephala*, 15–17 in *M. davyi* and 17–27 in *M. macowanii*. Leaf thickness varies between 0,35–0,45 mm in *M. aureocephala* and *M. davyi* but up to 0,55 mm in *M. macowanii*. *Ribs and furrows:* massive adaxial ribs with rounded to triangular apices associated with 1'vbs and small triangular ribs with 3'vbs. Medium depth adaxial furrows between all vbs; cleft-like depending on degree of infolding of leaf; Y-shaped as massive ribs almost meet laterally and then furrow diverges on either side of rib over 3'vb (Fig. 11); found in all specimens except certain *M. aureocephala* specimens where lateral 1'vbs are not interspaced by 3'vbs (Figs 7, 8 & 10). Abaxial surface smooth. *Median vascular bundle:* present, characteristically smaller than lateral 1'vbs. *Vascular bundle arrangement:* no 2'vbs present; 1'vbs and 3'vbs alter-



FIGS 1–11.—Anatomy of the leaf blade in transverse section of *Merxmuellera macowanii*, *M. davyi* and *M. aureocephala*. 1–3, 6, *M. macowanii*, all $\times 100$, considerable variation in leaf width evident. (1, Story 476; 2, Ellis 2394; 3, Ellis 3282; 6, Codd & De Winter 2329.) 4–5, *M. davyi*, $\times 100$. (4, Davidson & Mogg 33315; 5, Van der Schijff 5832.) 7–9, *M. aureocephala*, all $\times 100$, note sequence of vascular bundles. (7, Killick 3540; 8, Ellis 3179; 9, Edwards 843.) 10, *M. aureocephala*, $\times 400$. (Ellis 3179.) 11, *M. macowanii*, $\times 400$, phloem divided into two groups by intrusive fibres. (Ellis 3282.)

nate along width of lamina except near margin where two or more consecutive 1'vbs may be present; at least two 3'vbs occur between the median vb and these successive 1'vbs near the margin (Table 1) except in certain specimens of *M. aureocephala* (Figs 7 & 8) where only a single 3'vb may be present on either side of the median vb followed by four or five 1'vbs. All vbs located in centre of blade. *Vascular bundle structure*: vbs elliptical (Fig. 11) or round (Fig. 10) in outline; xylem and phloem distinguishable in 3'vbs; phloem of 1'vbs divided into two similar groups by intrusion of fibres (Figs 10 & 11). Protoxylem vessel and lysigenous cavity present; metaxylem vessels circular, of slightly greater diameter than obs cells. *Vascular bundle sheaths*: obs elliptical or horseshoe-shaped with wide adaxial interruptions; interruption especially pronounced in some *M. aureocephala* specimens (Fig. 10) such that obs only present opposite xylem; these specimens without adaxial interruptions or extensions (Fig. 10). In all other specimens adaxial extensions present; of colourless cells gradually decreasing in size as walls increase in thickness until they merge into sclerenchyma strand (Fig. 11). Obs cells slightly larger in diameter than mesophyll cells; all similar in shape; rounded; without chloroplasts. Ibs entire with uniformly thickened walls (Fig. 11) or with inner tangential walls thickened (Fig. 10) in certain *M. aureocephala* specimens. *Sclerenchyma*: adaxial girders inversely anchor-shaped with long, wide stem on all bundles. Abaxial sclerenchyma continuous sub-epidermal band of varying thickness, with large trapezoidal girders extending to, and interrupting, the obs. Fibres either heavily lignified (Fig. 10) or resemble collenchyma in section (Fig. 11). Marginal sclerenchyma cap small and pointed. *Mesophyll*: arrangement non-radiate; cells uniform, small, isodiametric and tightly packed. Restricted to Y-shaped groups on sides and bases of furrows. Arms of Y uneven due to difference in size of adaxial ribs associated with 1'vbs and 3'vbs (Fig. 11) except in certain *M. aureocephala* specimens (Fig. 10). *Colourless cells*: absent. *Adaxial epidermis*: restricted groups of 3–4 bulliform cells present at base of furrows; better developed in *M. macowanii* (Fig. 11) than *M. aureocephala* (Fig. 10) and *M. davyi*. In *M. davyi* prickles with straight, broad barbs and without bulbous bases common and well-developed (Figs 4 & 5); present in *M. macowanii* to a slightly lesser degree (Figs 1–3) but absent in certain *M. aureocephala* specimens where adaxial epidermis consists of papillate cells. *Abaxial epidermis*: no bulliform cells; outer periclinal wall thickened and covered by continuous, thickened cuticle. No macrohairs, prickles or papillae occur.

Abaxial epidermis

Intercostal zone: undifferentiated; entire abaxial epidermis essentially costal in structure (Figs 14 & 16) due to hypodermal sclerenchyma development. *Stomata*: absent. *Prickle hairs*: not present. *Microhairs*: not developed on abaxial surface. *Macrohairs*: absent. *Silica bodies*: elliptical (Fig. 13) to tall and narrow (Fig. 15); outlines smooth. Closely associated with cork cell or pair of short cells. Width of silica bodies narrower than adjacent costal short and long cells (Fig. 13). Silica bodies sparsely developed or even absent (Fig. 17). *Costal cells*: silica cells and cork cells, either singly or in pairs, alternate with costal long cells throughout abaxial epidermis. Long cells elongated; at least 3× longer than wide; sides parallel; anticlinal walls heavily thickened and slight-

ly undulating (Fig. 13) to strongly corrugated (Fig. 17).

Specimens examined:

M. macowanii

TRANSVAAL.—2530 (Lydenburg): Dullstroom (–AC), Codd & De Winter 3239; De Winter & Codd 183, 2730 (Vryheid); Wakkerstroom (–AD), Devenish 1152.

O.F.S.—2828 (Bethlehem): Golden Gate Highlands National Park (–DA), Ellis 2394.

NATAL.—2829 (Harrismith): Cathedral Peak Forest Reserve (–CC), Ellis 1455, 3282; Killick 1090, 2929 (Underberg); Estcourt (–BB), Acocks 10659, 2930 (Pietermaritzburg); Pietermaritzburg (–AC), Edwards 2673; Greytown (–BA), Ellis 3372.

CAPE.—3027 (Lady Grey): Barkly East (–DC), Joubert s.n. (Matatiele); Naudé's Nek (–CA), Story 476, 3126 (Queenstown); Buffelsfontein (–BC), Stretton 182.

M. davyi

TRANSVAAL.—2430 (Pilgrim's Rest): Mariepskop (–DB), Van der Schijff 5832; Wedernmann & Oberdieck 1908; God's Window (–DD), Davidson & Mogg 33315.

M. aureocephala

NATAL.—2829 (Harrismith): Cathedral Peak Forest Reserve (–CC), Ellis 3179, Killick 3450, 1727; Mweni Pass, Edwards 843, 2929 (Underberg); Cathkin Peak area (–AB), Edwards 2453.

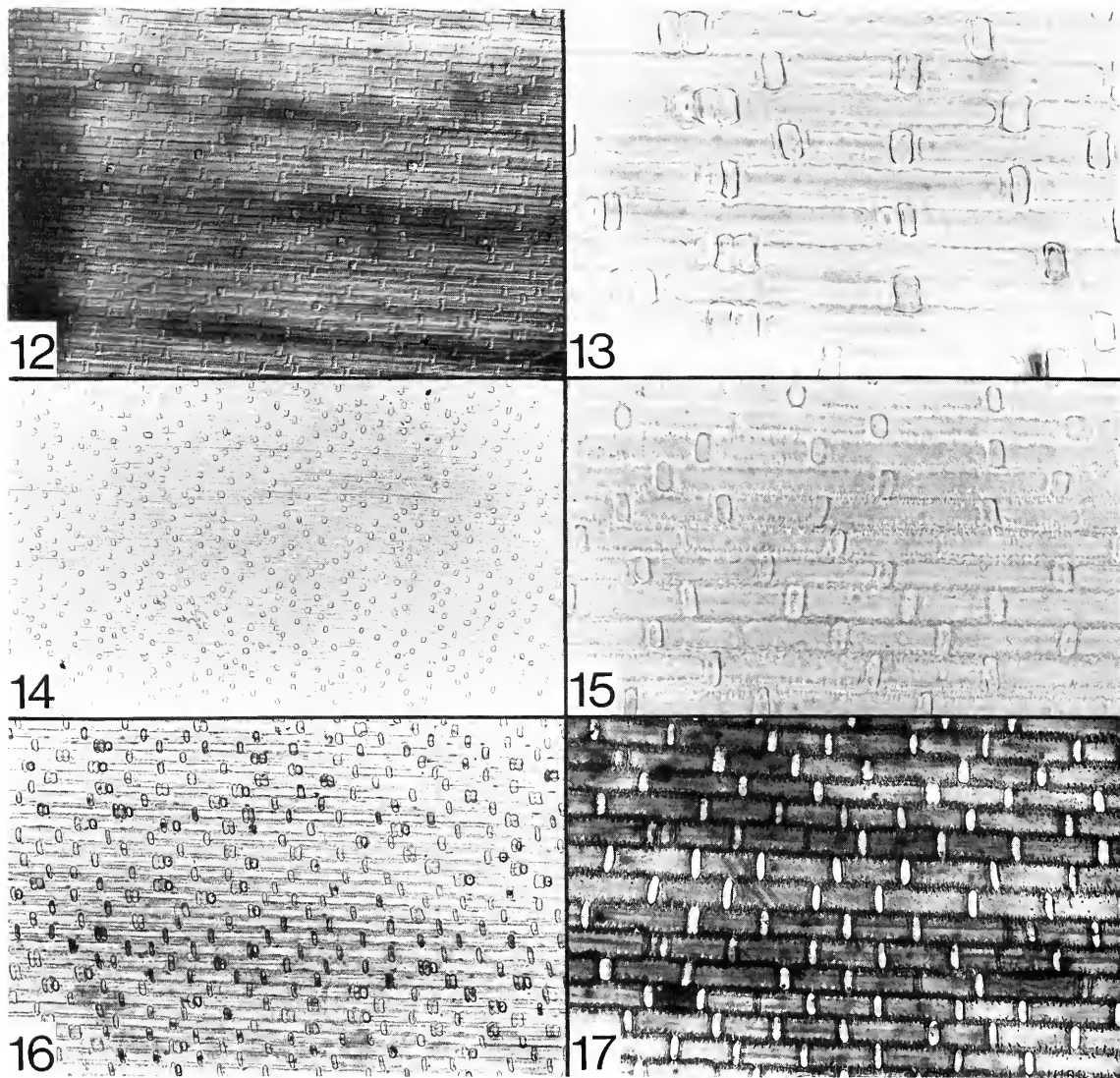
DISCUSSION AND CONCLUSIONS

The leaf anatomy of *M. macowanii* and *M. davyi* is remarkably similar—both the leaf in transverse section (Figs 1–6) and the abaxial epidermis (Figs 12–15). From the limited number of *M. davyi* specimens available for examination in this study (none of which was collected and fixed in the field), the only difference detected was a tendency for *M. davyi* leaves to be narrower with fewer vascular bundles per section. This is not a distinct difference, however, and several specimens overlap in this characteristic (Table 1). *M. macowanii* and *M. davyi* are considered to be closely allied (Anderson, 1962) and their leaf anatomy supports this close relationship. However, this anatomical evidence casts some doubt on the specific status accorded these two taxa and a closer comparison of these two species is necessary.

In contrast to the leaf anatomy, *M. macowanii* and *M. davyi* seem well separated ecologically and occupy different habitats—mesic streambank and seepage areas (Killick, 1963; Edwards, 1967) as opposed to drier rocky situations (Anderson, 1962). In addition, these two species are almost entirely separated geographically with only a small area of possible sympatry in the eastern Transvaal at Mariepskop and God's Window (Fig. 18). *M. davyi* extends northwards into central Africa along the eastern mountains, whereas *M. macowanii* occurs southwards as far as the north-eastern Cape.

Spikelet differences also appear to adequately differentiate these two species and the degree of fusion and the awned nature of the lemma lobes appear to be distinctive. In this respect *M. macowanii* and *M. davyi* apparently differ considerably and *M. davyi* actually bears a stronger resemblance to *M. aureocephala* than to *M. macowanii* which has characteristic adnate, awnless lemma lobes (Anderson, 1962).

Theoretically these ecological and morphological differences appear to be diagnostic yet in practice their application seems to have been inconsistent. Thus the specimens collected at God's Window and Mariepskop (Davidson & Mogg 33315 and Van der Schijff 5832) were initially identified as *M. maco-*



FIGS 12–17.—The abaxial epidermis of *Merxmuellera macowanii*, *M. davyi* and *M. aureocephala* as seen in surface view. 12–13, *M. macowanii*. (12, *De Winter & Codd* 183, $\times 250$, large number of single costal short cells without silica bodies; 13, *Stretton* 182, $\times 1\,000$, irregular short cell arrangement.) 14–15, *M. davyi*. (14, *Davison & Mogg* 33315, $\times 250$, only single short cells occur; 15, *Wederinnann & Oberdieck* 1908, $\times 1000$.) 16–17, *M. aureocephala*. (16, *Killick* 3450, $\times 250$; 17, *Ellis* 3179, $\times 640$.)

wanii and have only recently been assigned to *M. davyi* (Conert, 1975)—notwithstanding the fact that a key was published in 1962 specifically to facilitate the identification of *M. davyi*, *M. macowanii* and other closely related species (Anderson, 1962). In addition, the specimen *Codd & De Winter* 3239 has similarly proved difficult to identify satisfactorily. In 1947 it was named *M. macowanii*, changed to *M. davyi* in 1975 but again placed in *M. macowanii* during the present study. Anatomical indications are that this specimen is better placed in *M. macowanii* (Fig. 6).

Therefore, although anatomical evidence appears to be in conflict with morphological and ecological indications, closer analysis shows that *M. macowanii* and *M. davyi* are, in fact, not consistently separable and are probably very closely related. In the light of

the above evidence, a reassessment of their specific status, therefore, appears justified.

An additional consideration, which must be borne in mind when assessing the taxonomic status to be accorded these two taxa, is the almost identical situation observed in *M. drakensbergensis* and *M. stereophylla* (Ellis, 1981). These two species are also inseparable on anatomical grounds and a gradation in leaf size and vascular bundle number was also noted. Several other parallels exist between these two pairs of species. *M. drakensbergensis* and *M. macowanii* both occupy mesic, damp habitats and both display characteristic behaviour of the old leaf blades. *M. stereophylla* and *M. davyi* occur in drier, rocky situations and tend to have narrower leaves.

M. macowanii and *M. davyi* have purposely been considered separately from *M. drakensbergensis* and

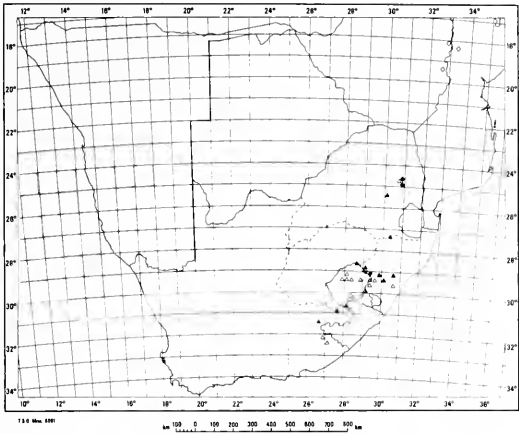


FIG. 18.—Distribution of *Merxmüllera macowanii* (△), *M. davyi* (◆) and *M. aureocephala* (▼) in southern Africa. Shaded symbols represent localities of specimens studied anatomically. Compiled from specimens at the National Herbarium, Pretoria (PRE).

M. stereophylla, even although they share so many common characteristics. This is because a distinct anatomical attribute consistently separates these two species pairs—the arrangement of the different orders of vascular bundles along the width of the lamina. In *M. macowanii* and *M. davyi* at least two alternating pairs of first and third order bundles, commencing with the median bundle, are present before consecutive lateral first order bundles are encountered (Table 1). In *M. drakensbergensis* and *M. stereophylla*, on the other hand, only a single third order bundle is present between the median bundle and successive lateral first order bundles. The alternating sequence of first and third order bundles is correlated with several other anatomical characters such as form of the adaxial furrows and shape of the mesophyll cell groups.

It is possible that position along the length of the leaf blade may affect this arrangement of the first

and third order vascular bundles. However, it has been shown that, towards the apex of the lamina, the lateral veins disappear one by one, commencing with the marginal pair, until the median bundle remains to form the pungent tip (Burbidge, 1946). It is unlikely, therefore, that the bundle sequence, as noted here, will be affected by the position of the sections examined as all material was taken from the central third of the leaf blade between ligule and apex (Ellis, 1976) and, in addition, the relevant bundle sequence is not marginal but adjacent to the median bundle or midrib (Table 1).

Up to this point *M. aureocephala* has been excluded from this discussion because, in respect of this anatomical difference, it does not conform with either of the vascular bundle sequences described above but exhibits mixed and intermediate conditions. Fig. 7 illustrates the condition typical of *M. drakensbergensis* and *M. stereophylla* where a single third order bundle is followed by successive first order bundles. Fig. 9, on the other hand, shows the alternating pattern of first and third order bundles characteristic of *M. macowanii* and *M. davyi*. *M. aureocephala*, therefore, exhibits both types of bundle arrangement that consistently separate *M. macowanii* and *M. davyi* from *M. drakensbergensis* and *M. stereophylla*. In addition, similar differences are found in different leaves of the same plant and even in single leaves. Thus leaf samples were taken from duplicate specimens of *Killick* 3450 and one showed the *M. drakensbergensis*/*M. stereophylla* type of bundle sequence (Fig. 7) whereas the other showed the *M. macowanii*/*M. davyi* type (Table 1). An exceptional case is illustrated in Fig. 8 where each of these two types of vascular bundle arrangement occur within a single leaf—one type in each half of the lamina.

The presence of all these intermediates in *M. aureocephala* casts some doubt on the importance attached to this difference in bundle arrangement in the present study. *M. aureocephala*, therefore, appears to hold the key to the understanding of relationships within this group of closely related species. Unfortunately, however, the taxonomic status of *M. aureocephala*

TABLE 1.—The arrangement of first (1') and third (3') order vascular bundles along the leaf blade from the median vascular bundle (midrib) to the margin

Specimens examined	Midrib				Vascular bundle sequence									
Merxmuellera davyi														
<i>Wedermann & Oberdieck</i> 1908	1'	3'	1'	3'	1'	3'	3'							
<i>Van der Schijff</i> 5832	1'	3'	1'	3'	1'	1'	3'							
<i>Davidson & Mogg</i> 33315	1'	3'	1'	3'	1'	3'	1'	1'	3'					
Merxmuellera macowanii														
<i>Killick</i> 1090	1'	3'	1'	3'	1'	1'	3'							
<i>Killick</i> 1090 (another leaf)	1'	3'	1'	3'	1'	3'	1'	3'	3'					
<i>Devenish</i> 1152	1'	3'	1'	3'	1'	3'	1'	3'	3'					
<i>Stretton</i> 182	1'	3'	1'	3'	1'	3'	1'	1'	3'					
<i>Ellis</i> 1455	1'	3'	1'	3'	1'	(3')	1'	1'	3'					
<i>Story</i> 476	1'	3'	1'	3'	1'	(3')	1'	1'	(1')	3'				
<i>Acoccks</i> 10659	1'	3'	1'	3'	1'	3'	1'	1'	3'	(3')				
<i>Codd & De Winter</i> 3239	1'	3'	1'	3'	1'	3'	1'	(3')	1'	(1')	3'			
<i>De Winter & Codd</i> 183	1'	3'	1'	3'	1'	3'	1'	(3')	1'	(1')	3'			
<i>Joubert</i> s.n.	1'	3'	1'	3'	1'	3'	1'	(3')	1'	1'	3'			
<i>Edwards</i> 2673	1'	3'	1'	3'	1'	3'	1'	(3')	1'	1'	3'	3'		
<i>Ellis</i> 2394	1'	3'	1'	3'	1'	3'	1'	3'	1'	1'	1'	3'		
<i>Ellis</i> 3282	1'	3'	1'	3'	1'	3'	1'	3'	1'	3'	1'	3'	1'	(3')
Merxmuellera aureocephala														
<i>Edwards</i> 843	1'	3'	1'	3'	1'	3'	1'	1'	3'	(3')				
<i>Killick</i> 3450	1'	3'	1'	3'	1'	1'	1'	1'	3'					
<i>Ellis</i> 3179	1'	3'	1'	(3')	1'	1'	1'	1'	3'					
<i>Edwards</i> 2453	1'	3'	1'	(3')	1'	1'	3'	(3')						
<i>Killick</i> 3450 (another leaf)	1'	3'	1'	1'	1'	1'	3'							

phala itself appears somewhat tenuous. To date this species is only known from six collections, all from a restricted area, of less than 20 km in diameter, in the subalpine belt of the Cathedral and Cathkin Peak areas of the Drakensberg (Fig. 18). Morphologically it is very similar to *M. davyi* except that the spikelets are larger in all parts, and the glumes are lanceolate instead of narrowly lanceolate (Anderson, 1962). Its winter-flowering habit, in fact, is the single diagnostic character separating *M. aureocephala* from its four close relatives. However, the specimens assigned to *M. aureocephala* may actually represent examples of late or early flowering in the other *Merxmuellera* species, e.g. *Edwards* 2284 has been determined by Conert 1973 as being *M. aureocephala*, but it is now considered as being *M. stereophylla*. Winter visits to these inhospitable mountains, to study fertile field populations, seem essential to a better understanding of the taxonomic status of all the summer-rainfall area *Merxmuellera* species.

Until these field studies have been undertaken, the true significance of the different vascular bundle arrangement sequences cannot be assessed. However, assuming that these patterns are a phylogenetically important difference, the available evidence indicates that *M. aureocephala* occupies a basic systematic position in this group from which each of the two distinct types have been derived. This implies a close relationship for these five species as postulated by Anderson (1962) as well as an origin in the Drakensberg mountains and not in the temperate, winter-rainfall areas of the Cape.

If the distribution of these two types of bundle arrangement is examined in all the summer-rainfall *Merxmuellera* species, however, a different origin seems likely. *M. disticha* (Nees) Conert, including each of its anatomical forms, exhibits the alternating sequence of first and third order vascular bundles (Ellis, 1980). *M. disticha*, therefore, shares this character with *M. macowanii*, *M. davyi* and some *M. aureocephala* specimens (Table 2). All the four *M. stricta* (Schrad.) Conert anatomical forms (including *M. guillarmodiae* Conert), on the other hand, have similar bundle arrangement to *M. drakensbergensis* and *M. stereophylla* as well as other *M. aureocephala* specimens (Ellis, 1980a) (Table 2). Thus, within this group of 12 summer-rainfall *Merxmuellera* taxa (Table 3), *M. aureocephala* remains the only taxon intermediate for this anatomical character.

Table 3 diagrammatically illustrates each of these twelve *Merxmuellera* taxa arranged according to vascular bundle sequence and grouped into the various habitats occupied by these various taxa. It is immediately evident from Table 3, that in each of the niches occupied by *Merxmuellera* spp. a taxon displaying each of the bundle sequence types occurs. A representative of each type of bundle arrangement occurs in the cave sandstone, basaltic soils, alpine bogs, alpine xeric sites and mesic sites. In addition, morphological and anatomical similarities often exist between these pairs of taxa inhabiting similar niches e.g. the old leaf blade behaviour in *M. macowanii* and *M. drakensbergensis* and the mesophyll and epidermal structure in the alpine bog forms of *M. stricta* and *M. disticha*. Once again, *M. aureocephala* is the exception.

Typical *M. stricta* and *M. disticha* forms are both widespread in the Cape and extend to lower altitudes in the Drakensberg. Throughout this wide distributional range both species are very uniform in both morphology and anatomy. It is only at higher altitudes, above the cave sandstone, that anatomical and morphological diversification is prevalent. An alternative hypothesis is, therefore, that *M. stricta* and *M. disticha* have independently colonized the wide variety of microhabitats present at higher altitudes in the Drakensberg by evolving locally adapted ecotypes for each of the various niches. This adaptive radiation, in response to identical environmental conditions, has resulted in very similar phenotypic expressions by the ecotypic forms of each species. As *M. stricta* and *M. disticha* occur sympatrically throughout most of their ranges it must be assumed that they originally possessed distinct but diverse genotypes which somehow were capable of responding in similar ways to the different environmental conditions encountered in the Drakensberg. This appears to explain the unique morphological and anatomical convergence observed in all the habitats occupied. The bundle sequence may, therefore, reflect a basic genetic difference between *M. stricta* and *M. disticha* ancestral forms that has been retained in all the ecotypic forms.

This hypothesis does not explain the position of *M. aureocephala*. If the origin of all these taxa is to be sought in putative ancestors of *M. stricta* and *M. disticha* then the only explanation for *M. aureocephala* lies in a hybrid origin. Once again population and cytogenetical studies seem necessary to elucidate this question.

From these antomical studies on the summer-rainfall *Merxmuellera* species (Ellis, 1980; 1980a; 1981) it is nevertheless clear that, at this stage, at least 12 entities can be recognized. A further two, presently placed in *Pentaschistis*, also merit consideration (Ellis, 1980a). All these taxa are undoubtedly interrelated and the most practical systematic treatment, at this stage, appears to be the upholding of only two basic species (*M. stricta* and *M. disticha*) with numerous infraspecific taxa, possibly of subspecific rank, included in each. *M. guillarmodiae*, *M. macowanii*, *M. davyi*, *M. drakensbergensis* and *M. stereophylla* should be reduced to subspecific rank, whereas, the anatomical forms of *M. stricta* and *M. disticha* justify taxonomic recognition with subspecific status as well. *M. aureocephala* is the one entity on which the present studies have shed very little light and a taxonomic recommendation at this stage would be unwise.

SPECIES	VASCULAR BUNDLE ARRANGEMENT
M.disticha	1' 3' 1' 3' 1' 3' (1' 3') (1' 3')
M.davyi	1' 3' 1' 3' (1' 3') 1' 3'
M.macowanii	1' 3' 1' 3' 1' 3' (1' 3') (1' 3') (1' 3') 1' 3'
M.aureocephala	1' 3' 1' 3' 1' 3' 1' 3'
	1' 3' 1' 3' 1' 3' (1' 3')
M.drakensbergensis	1' 3' 1' 3' (1' 3') 3'
M.stereophylla	1' 3' 1' 3' (1' 3')
M.guillarmodiae	1' 3' 1' 3'
M.stricta	1' 3' 1' 3' (1' 3') 3'

TABLE 2.—The arrangement of first (1') and third (3') order vascular bundles along the leaf blade from median vascular bundle to margin in the summer-rainfall *Merxmuellera* species

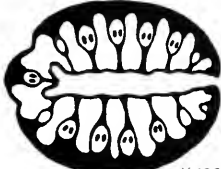
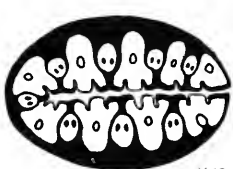

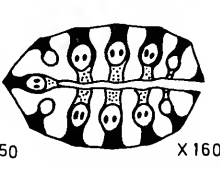
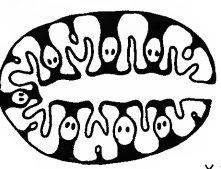








HABITAT	VASCULAR BUNDLE SEQUENCE		
	1° 3° 1° 1° etc.	1° 3° 1° 3° etc.	
WIDESPREAD S.W.- N.E. Cape; O.F.S. Sandstone	 M.stricta - X 160 typical form	 M. disticha - X 160 typical form	
DRAKENSBERG Subalpine belt Basalt	 X 250 M. stricta - drakensberg form	 X 160 M.guillarmodiae - Cathedral Peak form	 X 160 M. disticha - drakensberg form
DRAKENSBERG Alpine belt; summit Bogs + sponges	 X 250 M. guillarmodiae - alpine bog form	 X 250 M. disticha - alpine bog form	
DRAKENSBERG Alpine; Tvl. northwards Xeric, rocky sites	 X 160 M. stereophylla	 X 100 M. davyi	
DRAKENSBERG Alpine; E.Cape - Tvl. Mesic; streambanks	 X 160 M.drakensbergensis	 X 100 M. macowanii	
DRAKENSBERG Subalpine belt Winter flowering		 X 100 M. aureocephala	

TABLE 3.—Diagrammatic representations of the leaf anatomy of the summer-rainfall *Merxmuellera* taxa according to habitat and vascular bundle arrangement

ACKNOWLEDGEMENTS

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UITTREKSEL

Dwarssnitte en abaksiale epidermale skrapings, van herbarium, asook vars gefikseerde blaarmateriaal, van Merxmuellera macowanii (Stapf) Conert, M. davyi (C. E. Hubb.) Conert en M. aureocephala (J. G. Anders.) Conert is met behulp van 'n ligmikroskoop ondersoek. Die blaaranatomie van hierdie drie spesies is in alle opsigte dieselfde, met die uitsondering van sekere M. aureocephala eksemplare. Verder toon die anatomie 'n verwantskap tussen hierdie drie spesies en M. disticha (Nees) Conert. Hierdie spesiesgroep verskil anatomies van M. stricta (Schrader.) Conert, en verwante soorte soos M. drakensbergensis (Schweick.) Conert en M. stereophylla (J. G. Anders.) Conert, in die volgorde van die vaatbondels langs die blaarwydte en geassosiëerde kenmerke. Die M. aureocephala eksemplare wat nie die M. disticha tipe vaatbondelvolgorde toon nie, lyk anatomies na die M. stricta groep van spesies, en M. aureocephala is dus intermediêr tussen hierdie twee spesiegroepe.

REFERENCES

- ANDERSON, J. G., 1960. Notes and new records of African plants: Gramineae. *Bothalia* 7: 419-420.
- ANDERSON, J. G., 1962. Notes and new records of African plants: Gramineae. *Bothalia* 8: 170-172.
- BURBIDGE, N. T., 1946. Morphology and anatomy of the western Australian species of *Triodia* R. Br. 11. Internal anatomy. *Trans. R. Soc. S. Aust.* 70: 221-234.
- CHIPPINDALL, L. K. A., 1955. In D. Meredith, *The grasses and pastures of South Africa*. Johannesburg: CNA.
- CONERT, H. J., 1970. *Merxmuellera*, eine neue Gattung der Gramineen. *Senckenberg. Biol.* 51: 129-133.
- CONERT, H. J., 1975. *Merxmuellera guillarmodae* Conert n.sp. *Senckenberg. Biol.* 56: 145-152.
- EDWARDS, D., 1967. A plant ecology survey of the Tugela River Basin, Natal. *Mem. bot. Surv. S. Afr.* 36: 1-285.
- ELLIS, R. P., 1976. A procedure for standardizing comparative leaf anatomy in the Poaceae. 1. The leaf blade as viewed in transverse section. *Bothalia* 12: 65-109.
- ELLIS, R. P., 1979. A procedure for standardizing comparative leaf anatomy in the Poaceae. 11. The epidermis as seen in surface view. *Bothalia* 12: 641-672.
- ELLIS, R. P., 1980. Leaf anatomy of the South African Danthonieae (Poaceae). 11. *Merxmuellera disticha*. *Bothalia* 13: 185-189.
- ELLIS, R. P., 1980a. Leaf anatomy of the South African Danthonieae (Poaceae). 111. *Merxmuellera stricta*. *Bothalia* 13: 191-198.
- ELLIS, R. P., 1981. Leaf anatomy of the South African Danthonieae (Poaceae). 1V. *Merxmuellera drakensbergensis* and *M. stereophylla*. *Bothalia* 13: 487-491.
- KILLICK, D. J. B., 1963. An account of the plant ecology of the Cathedral Peak area of the Natal Drakensberg. *Mem. bot. Surv. S. Afr.* 34: 1-178.

Plants used by the Tsonga people of Gazankulu

C. A. LIENGME*

ABSTRACT

A study was undertaken in part of the Tsonga homeland, Gazankulu, to identify plants used by these people. A list of Tsonga plant names was extracted from a Tsonga-English dictionary and this was used as a basis for the study. The uses of almost 200 plants were recorded, including medicine, food, building materials, firewood, household utensils, implements, implement handles and toys. This information is presented in the form of an annotated list of the plants. This is followed by a discussion of some of the more important uses. Some of the aspects of Tsonga taxonomy are briefly discussed and illustrated with examples.

RÉSUMÉ

PLANTES UTILISÉES PAR LE PEUPLE TSONGA DE GAZANKULU

Une étude a été entreprise dans une partie du pays Tsonga, Gazankulu, afin d'identifier les plantes utilisées par ces personnes. Une liste de noms Tsonga de plantes a été extraite d'un dictionnaire Tsonga-Anglais et ceci fut utilisé comme base pour l'étude. Les utilisations de presque 200 plantes furent enregistrées, incluant les médicaments, l'alimentation, les matériaux de construction, le bois de chauffage, les ustensils ménagers, l'outillage, les manches d'outils et les jouets. Cette information est présentée sous forme d'une liste annotée de plantes. Ceci est suivi d'une discussion de certaines des plus importantes utilisations. Certains aspects de la taxonomie Tsonga sont brièvement discutés et illustrés avec des exemples.

INTRODUCTION

Much of the traditional culture and knowledge of the tribal people in southern Africa is in danger of being lost unless it is recorded. Tribal plant uses and botanical knowledge is of more than academic or historical importance and may be linked directly to plant utilization and conservation. The Botanical Research Institute has set itself the task of recording this information, commencing with a project in the northern Transvaal. The main aim of this project was to obtain a record of plants used by the Tsonga people of Gazankulu. A second aim was to test approaches to the gathering of ethnobotanical information prior to embarking on more extensive studies of the impact of tribal peoples on their environment.

The reasons for choosing Gazankulu as the study area were threefold. Firstly, it is a tribal area where traditional uses of plants have persisted. Secondly, it is a homeland area where a thorough knowledge of the plant-based tribal economy will be useful in future land-use and environmental planning. Thirdly, the author spoke the language, could communicate easily with the people and knew the area.

Study Area

The Gazankulu homeland consists of four separate units situated in the Transvaal Lowveld (see Fig. 1). The main block of the homeland, comprising the districts of Giyani and Malamulele, was chosen as the study area for this project. It is approximately 450 000 hectares in extent, lying west of the Kruger National Park, between the Levubu River to the north and the Letaba River to the south, with an arm in the middle stretching westwards to Elim Hospital.

Topography

The study area includes plateau areas (about 1 000 m altitude) and steep slopes and valleys at the plateau edge; but most of the area consists of low-lying plains (approx. 300–650 m altitude) with scattered hills.

In this preliminary study no attempt was made to define these areas or the plant uses peculiar to them.

Climate

The area has a hot, wet summer and a cool, dry winter. Spring is generally hot and dry and autumn warm and moist. The mean annual rainfall varies from 500 mm in the south-east to 1 000 mm in the

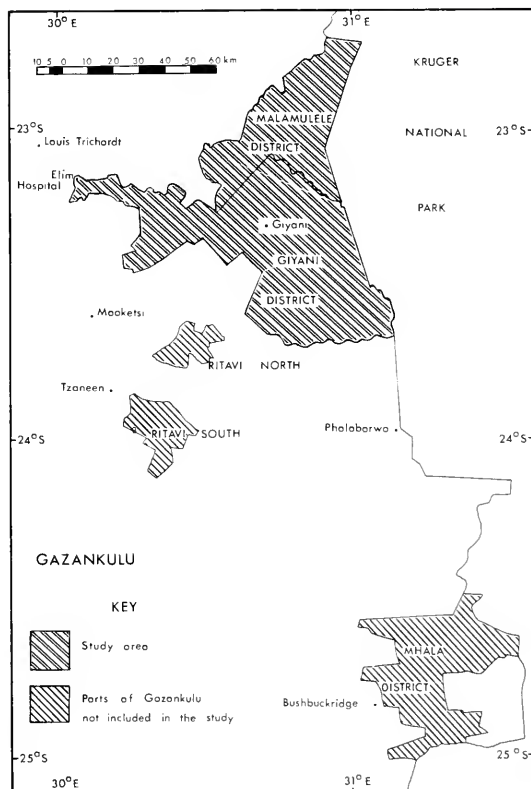


FIG. 1.—The location of the Gazankulu homeland.

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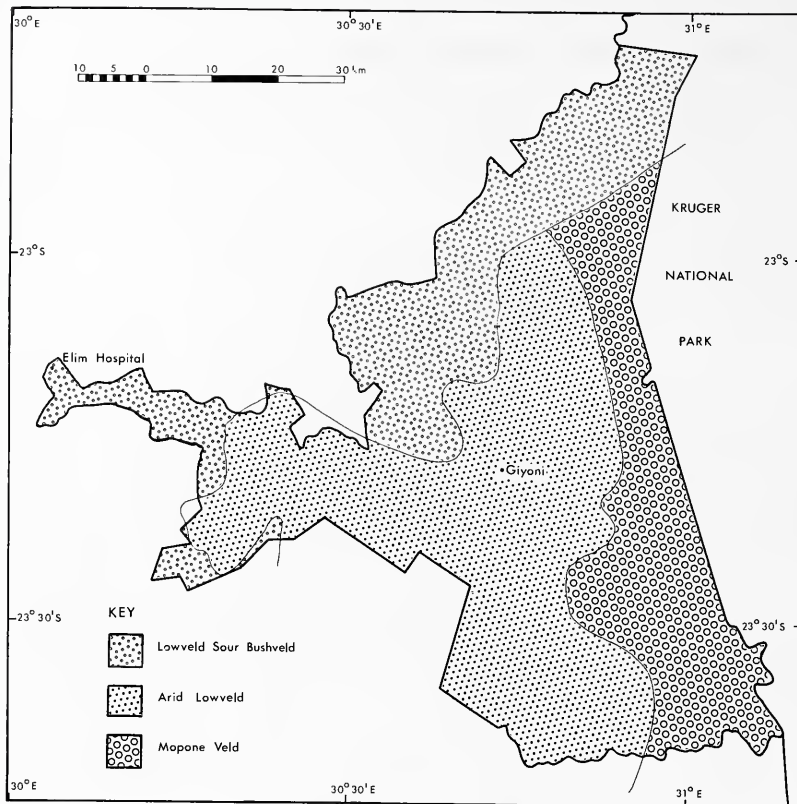


FIG. 2.—Acocks's veld types occurring in the study area. Redrawn from Acocks (1975).

west. Eighty to ninety percent of the rain falls in summer. Temperatures range from a mean winter minimum of 8°C to a mean summer maximum of 30°C. (Department of Co-operation and Development, pers. comm.).

Vegetation

The vegetation of the area includes three veld-types: Lowveld Sour Bushveld, Arid Lowveld and Mopane Veld (Acocks, 1975) (See Fig. 2).

The People

The life of the Tsonga people has been covered in great detail by Junod (1962). The Tsongas are basically agriculturalists, cultivating crops and keeping cattle and goats. They are dependent on the indigenous vegetation for many things, ranging from structural timber to supplementary food and medicine.

Historically, the Tsongas were an east coast people who occupied the southern half of Mozambique, the adjacent eastern edge of the Transvaal and north-eastern Natal (Tongaland). Many Tsongas migrated to the eastern Transvaal lowveld and adjoining escarpment areas on a number of occasions during the nineteenth century; firstly, during 1835–1840 when their country was conquered by Nguni who left Natal; secondly, during the 'War of Succession' between 1856 and 1862; and thirdly, during the war between the Portuguese and the Tsongas in 1894 and 1895 (Junod, *l.c.*). Many also migrated to the mining towns of the Transvaal in the early twentieth century. Today a number of Tsonga settlements are found as far west as the Waterberg District and Rustenburg (Van Warmelo, 1974).

Demography

The growth of the Tsonga population in Gazankulu as a whole has been rapid, from an estimated 37 000 in 1904 to 75 570 in 1951 and 350 245 in 1976. A further rapid increase is expected with populations of about 600 000 and 1 000 000 being projected for the years 2000 and 2020 respectively (Department of Co-operation and Development, pers. comm.).

In the study area the position is similar: following population influxes and with an estimated annual growth rate of about 5%, the area supported a population of just under 200 000 in 1976. (Department of Co-operation and Development, pers. comm.). This represents an average population density of 44 persons per square kilometre, with the western parts being the most heavily populated.

RESEARCH PROCEDURE

A list of approximately 550 Tsonga plant names was extracted from a dictionary (Cuenod, 1976) and was used as a starting point for the project. Field data sheets were devised for recording the use and the botanical name of each plant on the list as well as the locality and the informant.

As it turned out, the inhabitants of the study area often did not know some of the names incorporated in the dictionary. These were names used in other areas or referring to plants not occurring in the study area. Many of the names were synonymous, so that the final list of plants for which there were Tsonga names contained just under 400 plants. Information

on uses was obtained for almost half of these plants (190 species) and 170 specimens were collected.

The field work for the project was carried out during three trips to the study area between April and September 1977. An attempt was made to cover as much of the area as possible, visiting many of the not too inaccessible villages. The procedures used for gathering information were either:

1. to approach people whom the author knew to be helpful (who in turn often recommended others), or

2. to approach people at random along roads or in villages. These people were often engaged in particular activities that were worth recording, or revealed where to find knowledgeable people locally.

In all these contacts a knowledge of the language and way of life of the people was invaluable.

Both men and women were approached. Women were generally asked about plants used as food, thatch and mats and men about plants used in building and the making of utensils. Both men and women were asked about basketry and medicinal plants.

Most of the information on medicinal plants came from herbalists and information on plants from whose wood objects and utensils are carved from specialist woodcarvers, although some of these plant uses are common knowledge.

There were three approaches to questioning:

1. asking what a particular plant was used for; either giving its Tsonga name or pointing the plant out;

2. asking what plants in the locality were employed for various uses; and

3. on seeing a particular object or observing an activity (such as thatching), enquiring as to the plants used. Wherever possible, a specimen of the plant/plants was collected for identification. Colour slides and black and white photographs were taken, recording the utilization of plants.

The approach used depended largely on the situation. The first of the three approaches is only really effective if one points out a plant and asks about its uses. This approach is necessary if one wants to get both sides of the story (the plant side and the product side) in order to cross-check on information received. The second approach is useful for getting an idea of which plants have localized or widespread distribution and uses.

The most rewarding approach is the third since the informant is thoroughly familiar with the plant use. The object (finished or unfinished) is available and it is possible to record how the plants are prepared for use, how they are used, what other plants are used in conjunction with them, what part of the plant is used, how much wastage there is and what damage occurs to other plants in the process of collecting.

It soon emerged that many village and household activities are highly seasonal. Thus, continuous recording or more regular short visits to the area would be essential for any accurate quantitative assessment of the use of plant material to be made. The information on plants used by the Tsonga of Gazankulu presented here does not cover all seasons and should be regarded as a preliminary list only.

Verification of information on plant uses comes from two sources; literature and cross-checking in

the field, using information from a number of informants. The latter method works quite well in the case of plants with common, widespread uses. Specialist uses, for example medicinal uses, are not easy to check, since not all herbalists use the same plants.

Verification of information on plant uses comes from two sources; literature and cross-checking in medicinal plants. It was possible to verify the use of only 3 of the 35 Tsonga medicinal plants collected during this project. Fourteen other species were either used by other tribal groups for the same purpose as the Tsongas, or had related species with the same or similar medicinal use. In many other cases use of a plant was verified in the literature, but not for the Tsonga specifically. The most useful publications were Van Wyk (1972), Palmer & Pitman (1972), Watt & Breyer-Brandwijk (1962) and Shaw (1974). Junod (1962) provided verification of a few plant uses, but was most valuable for checking on traditional methods of thatching, building and basket-making.

THE PLANTS AND THEIR USES

The plants have been arranged in alphabetical order of their genus and species names. Tsonga names appear below the botanical names. Only original information on plant uses, gathered during the survey, has been included. Where a voucher specimen was collected, the collector's number is indicated in brackets after the plant name. Exotic species are indicated by *. Indexes of the uses and of the Tsonga names are appended to the paper.

Acacia ataxacantha DC. (Liengme 22)
muluwa

This is a fairly common tree in the Lowveld Sour Bushveld. It is often used as fuel, providing a very hot fire. Axe-handles are made from the wood and several types of baskets are made from thin strips of the wood. These strips are woven into mats and then shaped into baskets. The most commonly-seen baskets made in this way are: 1. a shallow saucer-shaped basket for winnowing, called a 'rihlelo', and 2. a fairly deep basket with a wide round opening. The latter normally has a winnowing basket as a lid.

Acacia caffra (Thunb.) Willd.
mbvinyaxihloka; nkaya/nkayi; nkhayani

A common tree in some parts, whose wood is hard and durable and is used for building, fence posts and firewood.

Acacia davyi N.E. Br. (Liengme 57)
xisidane

This small tree is another source of firewood.

Acacia gerrardii Benth. var. *gerrardii*
nsasani

This tree is not very common and seems to be more or less limited to the Lowveld Sour Bushveld areas. It is a source of firewood.

Acacia karroo Hayne (Liengme 9, 158)
munga

Its wood is an excellent firewood. The bark is used as cord and is sometimes made into ropes.

Acacia nigrescens Oliv.
nkaya/nkayi

The wood is hard and heavy and is used predominantly for building. It is also often used for making pestles. This is one of the characteristic trees of the Arid Lowveld and is plentiful.

Acacia sieberana DC. var. *woodii* (Burt Davy)

Keay & Brennan
nkwankowa

This common bushveld tree is used as firewood.

Acacia tortilis (Forssk.) Hayne subsp. *heteracantha* (Burch.) Brennan

ngoka; nsasani

This is another source of firewood.

Adansonia digitata L.

mowu/muwu; ximowu/ximuwu

The dry pulp of the fruit is eaten. This tree is almost entirely confined to the Mopane Veld.

Adina microcephala (Del.) Hiern var. *galpinii* (Oliv.)

Hiern
muhlome/nhlume/muthuma

The wood of this tree is strong and is sometimes used in building. It is also left standing in villages as a shade tree. Young branches make natural stirring sticks, used for stirring mealie meal (*Zea mays* meal) while it is cooking.

Afzelia quanzensis Welw. (*Liengme* 204)

nxenhe

The wood is used for building. This species occurs on hills and ridges in the Arid Lowveld and the Mopane Veld.

Agave sp.*

xikwenga

The fibre extracted from the leaves of this exotic is used for making string, ropes, table mats and other items. The fibre is still extracted manually at home, but most people now buy the string. Prior to the introduction of *Agave* the fibre of *Sansevieria* species was probably used. In the vicinity of the large *Agave* plantations scattered around Gazankulu the inflorescence stalks are used as fencing material.

Albizia harveyi Fourn.

mola/molani; molela

This tree is often found in villages as a shade tree. It is also used as firewood.

Albizia versicolor Welw. ex Oliv. (*Liengme* 108)

mbhesu/mbheswi; muvambangoma; mvhangazi wo basa; mucece

The Tsonga name 'muvambangoma' can be translated as meaning 'stretched out like a drum skin' ('-vamba'-stretch out; 'ngoma'-drum). 'Muvhangazi wo basa' can be translated as 'white kiaat' ('muvhangazi' is the Tsonga name for kiaat and 'basa' means white). The roots and bark of the tree are apparently used to make a medicine for driving out demons. The wood is hard and quite beautiful and is used for carving mortars and other objects. The tree is also regarded as a useful shade tree in villages.

Allophyllus decipiens Radlk. (*Liengme* 51)

muzuzugwane xihlahla

This is a fairly common small tree used as firewood.

Aloe davyana Schoenl. var. *davyana*
mhangani

The leaves of this aloe are used in a game played by children. The nature of the game is uncertain.

Amaranthus cruentus L. (*Liengme* 100)

nhlaba ya fole

Snuff is made from the flowering tops of the plant.

Amaranthus thunbergii Moq. (*Liengme* 175)

thyeke/thyeke

This is a common ruderal herb near dwellings and in old fields. The leaves are cooked, usually as a constituent of relishes.

Annona senegalensis Pers. (*Liengme* 12)

murhompfa; muyembe; ndzompfa/ndzopfa/ndzhopfa

The pulp of the fruit is eaten, but the plant is not common enough for it to be important in the diet. The empty fruit is used by children to make a 'pop-gun'. Openings at each end of the fruit are plugged with pieces of mealie (*Zea mays*) cob. If the plug at one end is hit hard the plug at the other end pops out.

Antidesia venosum E. Mey. ex Tul. (*Liengme* 24)

mpfalambati; mphatakhwari

The fruit is eaten and the plant is one of those whose young flexible branches are used as wattles in building. This is a species of the Lowveld Sour Bushveld.

Aptosimum lineare Marloth & Engl. (*Liengme* 92)

ximahlomahlwane

The juice of the leaves of this small herbaceous plant is used by herbalists as eye-drops.

Arachis hypogea L.*

manga

Peanuts are cultivated in some parts of Gazankulu.

Artabotrys brachypetalus Benth. (*Liengme* 219)

ntita/ntiti/ntinta; xivudzi

A strong fibre is obtained from this scrambling plant, which occurs in the Lowveld vegetation types. The fruit is eaten and the plant also has medicinal uses.

Asclepias burchelli Schltr. (*Liengme* 84)

kotoni

A decoction of the roots is used for the treatment of intestinal worms.

Asparagus virgatus Bak. (*Liengme* 141)

nkungulantila/nkwangulantilo

This plant is thought to have magical properties. When unwanted rain threatens, a plant is cut and set alight. The youngest child in the family waves this around to chase the rain away.

Athrixia phyllicoides DC. (*Liengme* 21)

kofi ya nhova

The leaves of this plant are used to make a hot drink, like tea.

Balanites inaughanii Sprague (*Liengme* 107)
nulu

This small tree occurs in the vicinity of hills on the lowveld plains. The roots are pounded and made into a medicine for apparently driving out demons. A musical bow called 'xipendane' is made from this wood.

Bambusa sp.*
musengele

This exotic species is found growing in some places. Stems are split and used for fences and palisades.

Bauhinia galpinii N.E. Br.
ntshwiriri/ntshiriri

The seeds of this rambling shrub are used as beads for necklaces. This is a distinctive species of the Lowveld Sour Bushveld.

Bequaertiodendron magalismontanum (Sond.) Heine & J. H. Hemsl. (*Liengme* 208)
nombela

The fruit of this tree is very pleasant-tasting. The tree occurs in the Lowveld Sour Bushveld.

Bercheinia discolor (Klotzsch) Hemsl. (*Liengme* 118)
nyiri/nyiyi/muwe

Pestles, axe-handles and other objects are carved from the wood. The fruit is eaten, especially by children.

Bidens pilosa L.*
muxiji

This is a common ruderal around dwellings and in fields. The leaves are cooked in relishes or as 'spinach'.

Blumea aurita (L.f.) DC. (*Liengme* 221)
munywane

This plant is placed in hot water to make a medicine and applied to sore places on the body. It is considered to be the male form of 'munywane'; the female form being a plant identified as *Epalties gariepina*.

Bolusanthus speciosus (H. Bol.) Harms
mpfimbahongonyi; nkamba/nkhamba; nkohlwane

The wood of this tree is recognized as being good for making furniture. It is often used for implement handles and walking sticks. There is a substance in the roots which is reputed to have a sleep-inducing effect.

Brachylaena discolor DC. subsp. *transvaalensis* (Phill. & Schweick.) J. Paiva (*Liengme* 14)
mphata

Young stems and branches are strong and pliable and are used in making the rims of winnowing and other baskets made from strips of *Acacia ataxacantha* wood. The outer of the two wooden rings of the rim is made from this plant. Young stems and branches are also used for tying together roof frameworks. The tree is also a source of firewood. It occurs in the Lowveld Sour Bushveld.

Bridelia micrantha (Hochst.) Baill. (*Liengme* 18, 53)
mindzere/mundzere/ndzerhe

This is another species occurring in the Lowveld Sour Bushveld. The bark is used by herbalists and

witch-doctors to make a stomach medicine. The fruit (small berries) are eaten, particularly by children.

Bridelia mollis Hutch. (*Liengme* 214, 224)
kumbekumbe; swatima; swimbyambya

The small fruit is eaten.

Burkea africana Hook.
mpulu; nkenga

This tree is rare in the study area, being found only occasionally in the Lowveld Sour Bushveld. The wood is recognized as being good for furniture, having a good texture and colour and not splitting and twisting as it dries.

Cajanus cajan (L.) Millsp.* (*Liengme* 162)
ndodzi

The pigeon pea is cultivated in some of the moister western parts of the study area.

Calodendrum capense (L.f.) Thunb.
mbhovu

The dried fruits of this tree are used to make ankle-rattles which are worn by dancers at celebrations and feasts.

Capparis fascicularis DC. var. *fascicularis*
muhobadale

The roots of this creeper are used for medicinal purposes, of uncertain nature.

Capparis tomentosa Lam. (*Liengme* 232, 242)
khawa; mukorongwe

The roots are used to make a stomach medicine. The plant is fairly common in the Arid Lowveld.

Capsicum frutescens L.*
viriviri

Peppers are occasionally found in gardens.

Carissa edulis Vahl (*Liengme* 11, 223)
nchungulu/nchuguru/ntshuguru

This is a common shrub of the Lowveld Sour Bushveld, producing large quantities of fruit in mid-to late summer. The fruit is delicious and is eaten fresh by all.

Cassia abbreviata Oliv. subsp. *beareana* (Holmes) Brenan
lumanyama/numanyama

This tree is sometimes left standing in villages as a shade tree.

Cassia occidentalis L. (*Liengme* 44)
nembenembe

The seeds are cooked and eaten, but its importance as a foodstuff is not known. The plant is common in the moister areas and is often found along roads.

Cassine aethiopica Thunb. (*Liengme* 212)
nqayi

The wood of this tree is popular for making walking sticks.

Cassine transvaalensis (Burt Davy) Codd (*Liengme* 138)
ximapana; nkubatsebi

This tree has strong wood which is used for implement handles, yokes and spoons.

Catha edulis (Vahl) Forssk. ex Endl.
rithadzi

Young branches of this tree are used as withies for roof frameworks. The stimulant properties of the leaves are apparently not known.

Cephalanthus natalensis Oliv.
muthondwa/ntondo

This is a fairly abundant climber in the Lowveld Sour Bushveld. Its somewhat bitter fruit is eaten.

Clematis brachiata Thunb. (*Liengme* 63)
maamba; mikoka

The leaves of this common herbaceous climber are boiled in water and a person suffering from a headache inhales the vapours while seated under a blanket. The roots are crushed and placed in the nose to clear up colds.

Cocculus hirsutus (L.) Diels. (*Liengme* 81, 189, 237)
risotse/rixoto; xotse/xotso

This is a common climber in the Arid Lowveld and Mopane Veld whose stem is used for making baskets, especially conical baskets called 'xirundzu'. During the dry season the leaves remain green and are sometimes cooked and eaten as a vegetable.

Colocasia antiquorum Schott* (*Liengme* 34)
raboda; rupi

This exotic is sometimes found growing along streams in the moister western parts of Gazankulu. The leaves are cooked and eaten.

Colophospermum mopane (Kirk ex Benth.) Kirk ex J. Leonard (*Liengme* 91)
nxanatsi

The mopane tree is the dominant woody plant of the Mopane veld which covers a considerable part of the study area. The wood is hard and durable and is the major building material where it occurs, being used for roof supports, roof frameworks, fence-posts and stockades. The wood is widely used as firewood and is recognised as one of the best firewoods. It is also used for making pestles, yokes and sand-sledges. The bark is very fibrous and is used as cord. The tree is an indirect source of food to the people, being the food-plant of the mopane worm (the larva of the moth *Gonimbrasia belina*). This worm occurs in summer. It is collected, dried and stored for eating.

Combretum apiculatum Sond. subsp. *apiculatum* (*Liengme* 77, 126)
mpotsa/mpoza; mugarasaka

The wood of this common tree is hard, making it useful material for building and fence-posts. Implement-handles and spoons are also made from the wood.

Combretum erythrophyllum (Burch.) Sond. (*Liengme* 36)
mbvuvu/mvuvu; mgupa

The wood is used as fuel, but this is not common practice. The tree is more or less confined to stream banks.

Combretum hereroense Schinz. subsp. *hereroense* var. *hereroense* (*Liengme* 76)
mpotsa/mpoza; xikhavi

The wood is cut for building and is also used for axe-handles and pick-handles. Various wooden items

are carved from it. The young branches are strong and flexible and are used as withies.

Combretum imberbe Wawra (*Liengme* 98)
mbimba; mondzo

The wood is very hard and durable and is frequently used in building, usually for the main supporting poles of a hut. Mortars are carved from the wood and sometimes pestles as well. This species occurs in the Arid Lowveld.

Combretum paniculatum Vert. subsp. *microphyllum* (Klotzsch.) Wickens (*Liengme* 199)
chochelamandleni yanstongo; mpfunta; mpfunte-mpfunte

The Tsonga word 'chochelamandleni' means 'tap out into the hand', referring to the use of the plant by children: they shake the nectar from the flowers into their hands and then lick it up. A diminutive is formed by the addition of 'ya ntongo' to the name. The tree *Schottia brachypetala* is the actual 'chochelamandleni'. The plant is a straggly, scrambling shrub occurring along river banks, flowering profusely in spring.

Commiphora pyracanthoides Engl.
xifata/xifati

The wood is extremely useful and is used for bowls, plates, axe-handles and a musical instrument called 'mbila'.

Corchorus confusus Wild (*Liengme* 193)
guxe

The leaves of this ruderal, common in villages and along roads, are cooked in a relish or gravy and eaten with mealie meal (*Zea mays* meal).

Corchorus tridens L. (*Liengme* 93)
guxe

This species is used in the same manner as *Corchorus confusus*.

Cordia grandicalyx Oberm.
ntogwe; tshaman'hwati

The dried fruit is used to make ankle-rattles for dancing.

Cordia ovalis R. Br. ex DC. (*Liengme* 75, 85, 227)
mpon'wana; mtlele

The young branches are flexible and are used as withies as well as for securing thatch to roofs. The fruit is eaten, generally by children.

Crossopteryx febrifugia (Afzel. ex G. Don) Benth.
nkombekwa/nkombelwa

Bowls and other utensils are carved from the wood.

Croton megalobotrys Muell. Arg. (*Liengme* 95)
nxunguxungu/nxungwexungwe

A purgative medicine is made from the pounded bark added to a few other ingredients. The plant is recognized by most people as being poisonous and dangerous. It seems to occur in the riverine vegetation.

Cryptolepis capensis Schltr. (*Liengme* 96)
nyokani

The roots of this forb are used to make a worm remedy. The use of the plant is indicated by its name; 'nyoka' means 'snake or worm'.

Cucumis melo L.* (*Liengme* 121)
rhanga

The fruit of this small melon is cooked and eaten. It is not certain whether this plant is cultivated or not, but specimens were found growing wild. The fruit of the collected specimen was about 100 mm long, oval and yellow.

Cucurbita maxima Duch.*
gawana; rhanga; xilutana

Squashes are commonly cultivated in Gazankulu, probably more so than *Cucurbita pepo*.

Cucurbita pepo L.*

Pumpkins are also cultivated.

Cussonia spicata Thunb.
musenje; xipokota

Planks are sometimes cut from the wood.

Cynbopogon validus (Stapf) Stapf ex Burt Davy
(*Liengme* 29, 181)
mgejo; deke

This grass is common in the Lowveld Sour Bushveld. It is used as thatch, particularly as the first layer of the thatch (the 'ceiling'). The name 'deke' is most probably derived from the Afrikaans word 'dak'.

Cyperus latifolius Poir. (*Liengme* 5)
njejejeke (leaves); xigoya (culm)

Both the leaves and the culms are used to make mats. The plant is abundant along streams in the Lowveld Sour Bushveld.

Cyperus sexangularis Nees (*Liengme* 186, 246)
nhlahle; risama

This occurs along rivers and streams in the Arid Lowveld and Mopane Veld and is used there to make mats.

Cyphostemma humile (N.E. Br.) Desc. ex Wild & Drum. subsp. *humile* (*Liengme* 172)
ndlejana

The leaves of this succulent are crushed and the liquid used as ear-drops.

Dalbergia inelanoxylon Guill. & Perr. (*Liengme* 120)
xilutsi; xipalatsi

The wood is much sought-after by wood-carvers, because of its beautiful black heartwood. The wood is used for ornaments, walking sticks, knobkieries and also for headrests. Reasonably large specimens of the species seem to be rare.

Dicrocaryum zanguebarium (Lour.) Merr. subsp. *zanguebarium* (*Liengme* 88)
dinda/dindza; hlwehlwe (seed)

The plant's juice is used as a shampoo. It is common in the Arid Lowveld and the Mopane Veld.

Diachrostachys cinerea (L.) Wight & Arn. subsp. *africana* Brenan & Brumitt (*Liengme* 25)
ncenga; ndhenga/ndzhenga

This small common tree/shrub is used as firewood.

Dioscorea cotinifolia Kunth (*Liengme* 28)
nsidwa; risidwa

The tough stems of this climber are used in basket-making. They are used for binding the rims and waists of baskets to the body of the basket.

Diospyros mespiliformis Hochst. ex A. DC.
mgula; ntoma

The fruit of this tree, common in the Lowveld Sour Bushveld and Arid Lowveld regions, ripens in late winter. Cultivated food can be quite scarce at this time of the year and the fruit is thus an important food resource. The wood is used to make mortars, door frames, hut poles and yokes and occasionally pestles.

Diospyros natalensis (Harv.) Brenan subsp. *xintomantomane*

The Tsonga name can be taken to mean 'little Diospyros'. Sticks are cut from this shrub and used to build palisades (walls around or between a group of huts), as well as being used as withies in hut building. The fruit is eaten.

Dodonea viscosa Jacq. var. *viscosa* (*Liengme* 216)
mudodivisa

This is grown as a hedge in many villages.

Dombeya burgessiae Gerr. ex. Harv. (*Liengme* 3)
mukurhu

The bark of this small shrub is strong and is used as cord. The plant occurs as an understorey plant in the forest along the escarpment in the extreme west of the study area.

Dombeya rotundifolia (Hochst.) Planch. var. *rotundifolia* (*Liengme* 78)
mbikanyaka; nsihapukuma; xiluvharhi

The wood is used for many purposes, from building to carving spoons for stirring food. The flowers are believed to have magico-medicinal properties. They are sprinkled over a hen's eggs to prevent the chickens from dying once they have hatched.

Dovyalis zeyheri (Sond.) Warb. (*Liengme* 50)
chipachipachane;

This is another source of firewood.

Ekebergia capensis Sparrm.
nyamarhi

This is one of the trees left standing in villages to provide shade.

Epaltes gariiepina (DC.) Steetz (*Liengme* 220)
munywane

A medicine is made from this herbaceous plant for relieving pain. The medicine is made by placing the plant in hot water. The lotion is then applied to the affected part of the body. This species is considered to be the female form of the plant 'munywane'. *Blumea aurita* is the male form. Both are used for the same kind of medicine.

Erythrina lysistemon Hutch.
muvale; nsisimbana

The wood is not strong and is only used occasionally as fence-posts. Truncheons are planted to provide a living fence.

Eucalyptus spp.*
ndlulamithi

Gum poles can be bought from timber producers near the homeland and are often used instead of indigenous timber in the construction of roofs.

Euclea crispa (Thunb.) Guerke var. *crispa* (Liengine 194, 203)
xintomantomane

This species has the same Tsonga name as *Diospyros natalensis*, indicating that the Tsonga consider the two plants as the same or similar. The branches of this shrub are flexible and are used as withies in hut construction. It is common in the Mopane Veld.

Euclea divinorum Hiern (Liengine 111, 226)
nhlangula/nhlohlangula

The fruits are eaten, mostly by children.

Faurea saligna Harv.
muthango; n'wamidzumba

This is recognized as a good timber tree and is used for building and furniture. It occurs occasionally on the western edge of the study area, in the Lowveld Sour Bushveld. The wood is also used as firewood, but it is said that a fire made with this wood needs to be well-tended or it goes out. The nectar is sucked out of the flowers by children.

Faurea speciosa (Welw.) Welw. (Liengme 17)
muthango; n'wamidzumba

This species is generally found at higher altitudes than *Faurea saligna*. It is not distinguished from that species by the Tsonga, having the same names and uses.

Ficus burkei (Miq.) Miq. (Liengine 157)
xirhombe; xirhomberhombe; nhlulawumbe

The bark is easily stripped off young branches and is used as cord.

Ficus capensis Thunb. (Liengme 151)
nkuwa

This tree is found along streams in the Lowveld Sour Bushveld regions. The 'fruit' is edible but is usually infested with insects. The wood is sometimes used as fuel.

Ficus capreaefolia Del. (Liengme 104)
phalavurha; xinkuwana

This species occurs along river banks in the Arid Lowveld and Mopane Veld. The young branches are very flexible and are used as withies. The 'fruit' is eaten.

Ficus soldanella Warb. (Liengine 109)
nkuwa ya tintsava

This species of *Ficus* is found on rocky hills in the lowveld, often actually growing on rocks. Its Tsonga name is indicative of its habitat, meaning 'the fig of the hills'. The 'fruit' is tasty and is eaten.

Ficus sonderi Miq. (Liengme 117, 222)
xirhomberhombe xa tintsava

The Tsonga name for this tree is also indicative of its habitat, meaning the 'xirhomberhombe' of the hills. The 'fruit' is sometimes eaten.

Ficus stuhlmannii Warb.
nhlulawumbe; xirhombe; xirhomberhombe

The 'fruit' of this fig is sometimes eaten, but it is apparently not as pleasant as some of the other species.

Ficus sycamorus L. (Liengine 139, 148, 217)
nkuwa

This large tree occurs mainly along river banks, but in the Lowveld Sour Bushveld it is also found away from the rivers. Here it is often one of the few trees remaining in the field and in villages. The 'fruit' is edible, but, as with many wild figs, is usually infested with insects.

Flacourtia indica (Burm. f.) Merr.
muqokolo/nqokolo; xivambula

The fruit is eaten.

Garcinia livingstonei T. Anders.
mbhimbi/mhimbi

This tree is not very common in the study area. The fruit is eaten and is also used to make an alcoholic beverage. Whether this practice is common or not is uncertain.

Gardenia spatulifolia Stapf & Hutch.
ntsialala; xitsalala

The heartwood of this tree/shrub is dark and spoons are carved from it. It is thought that a stick cut from this species and placed in the ground inside a witch-doctor's hut will protect him, presumably from evil forces.

Gnidia rubescens B. Peterson (Liengme 228)
xinyokanyokane

A worm medicine is prepared from the roots of this herb.

Gossypium herbaceum L. var. *africanum* (Watt)
J. B. Hutch. & Ghose (Liengine 80)
miseha; ricinda

The boll provides a fibre which is little used today. It was used previously in much the same way that cottonwool is used today.

Grewia species
nsihana

The name 'nsihana' appears to be a generic name for the *Grewia* species.

Grewia flavescens Juss. var. *flavescens* (Liengme 244)
nciwana; nsihana

The wood of this common shrub is used for making musical instruments and rims and basal rings for baskets. The fruit is eaten.

Grewia flavescens Juss. var. *olukundae* (Schinz)
Wild (Liengme 97, 131)
nsihana yo kulu

The Tsonga name means 'large *Grewia*'. The fruit is edible, being particularly favoured by children.

Grewia occidentalis L. (Liengme 142)
ntsepukane; ntswukelane

This is a species of the Lowveld Sour Bushveld. The leaves are cooked and eaten as a vegetable.

Heteropogon contortus (L.) Beauv. ex Roem. & Schult. (Liengine 83, 177)
xilungwa

This grass is used for thatching roofs by the method of tying the grass into mats first and then attaching these to the roof.

Heteropyxis natalensis Harv. (*Liengme* 20)
nthathasani

Spoons are carved from the wood of this small tree. It occurs in the Lowveld Sour Bushveld.

Hexalobus monopetalus (A. Rich.) Engl. & Diels
(*Liengme* 72)
mbomu; nxakama

The fruit of this small tree is eaten.

Hibiscus cannabinus L.
ntsembyana/ntswembyane

The bark of this plant is very fibrous and it is used for making twine and rope. It is a weed, often seen along roads and in old fields.

Hyparrhenia dichroa (Steud.) Stapf (*Liengme* 31,
160, 164, 184, 192)
ntsenga; tlongwe

This is one of the several species of this genus that are used as thatch. *Hyparrhenia* species are common in the Lowveld Sour Bushveld, but not in the other two veld types. Most of the species have the same Tsonga names.

Hyparrhenia dregeana (Nees) Stapf ex Stent
(*Liengme* 30)
ntsenga

A thatch grass.

Hyparrhenia hirta (L.) Stapf (*Liengme* 165, 183, 191)
ntsenga; tlongwe; deke

Another thatch grass. The last of the Tsonga names is probably derived from the word 'dak'.

Hyparrhenia rudis Stapf (*Liengme* 6)
ntsenga

Also a thatch grass.

Hyparrhenia tamba (Hochst. ex. Steud.) Anders. ex
Stapf (*Liengme* 130)
tlongwe

A fifth *Hyparrhenia* species which is used as thatch.

Hyperthelia dissoluta (Nees) Clayton (*Liengme* 7,
167, 179, 180, 185, 188)
tlongwe

This is a common grass of the Lowveld Sour Bushveld, which is used as thatch.

Hyphaene natalensis Kunze
vucema

This palm is rare in the study area and is protected. The leaves were used to make certain types of bags and baskets as well as beer-strainers. These objects are not very common any more because of the scarcity of material.

Ipomoea batatas (L.) Lam.*
gapi (tuber); ritiyi

The sweet potato is cultivated in many parts of the study area.

Jatropha curcas L.* (*Liengme* 154)
nhlamfura ya valungu

This exotic is found in many villages. The people know that the seed contains oil but they don't seem

to use it. It is very poisonous and there have been a number of cases of poisoning of children by the fruit.

Kigelia africana (Lam.) Benth. (*Liengme* 94)
mpfungu/mpfungurhu; muveve

This large tree occurs predominantly near rivers. The large fruit is burnt when an unwanted storm threatens. Dense smoke is produced and this is believed to chase the clouds away. The pulp of the fruit is known to have been ground into flour and used as food during famines.

Lagenaria siceraria (Molina) Standl.
rindanga

The calabash is widely cultivated in Gazankulu. Besides being used as a vegetable, it also provides bowls and scoops.

Landolphia kirkii Dyer (*Liengme* 207)
muvungwa; mungu

This scrambling plant of the rocky hills has edible fruit.

Lannea discolor (Sond.) Engl. (*Liengme* 70)
ximutswani; ximombyana; xinkanyana; mumbumu-
mbu; ximpupyani

The Tsonga name 'xinkanyana' can be taken to mean 'the little marula': the marula is called 'nkanye'. The fruit is eaten and the bark is used as cord.

Lannea edulis (Sond.) Engl.
nchuchungwa

The small fruit is eaten.

Lannea stuhlmannii (Engl.) Engl. (*Liengme* 245)
ndivata/ndzivata; ximbukanyi; ximombonkanyi

The bark provides a purplish brown dye which is used for drying the materials used in basket-making in order to give the baskets coloured stripes or patterns. The bark is also used as cord. The wood of the roots is sometimes used in the rims of baskets. The fruit is eaten. The Tsonga name 'ximombonkanye' means 'it has the face of the marula': 'mombo' means 'face' and 'nkanye' is the marula tree. This corresponds to the English common name of the species—bastard marula.

Lantana rugosa Thunb. (*Liengme* 87)
tihove ta valungu

The fruit is eaten by children.

Leonotis sp. (*Liengme* 102)
mahlanganiso

The Tsonga name of this plant is derived from the verb 'hlanganisa' which means 'to unite or join'. If a person has a broken bone, the witch-doctor pricks the skin in the region of the break and applies a lotion made from the tops of the plant. This is thought to heal the bones quickly.

Lippia javanica (Burm. f.) Spreng. (*Liengme* 27)
musuzwane; ntungufana

Plants are cut and tied together to make rough brooms. The plant also has a number of medicinal uses. The leaves are boiled in water to make a cough medicine and a bleeding nose is cured by plugging it with leaves. The plant occurs commonly in the Lowveld Sour Bushveld, especially in areas where the bush has been cleared.

Lonchocarpus capassa Rolfe
mbhandzu/mbhandzwa

This tree is fairly common in the Arid Lowveld and Mopane Veld areas, particularly along rivers. A decoction of the bark is used as a cure for colds.

Maerua angolensis DC. (Liengme 174)
xiyimanamurhi

A purgative medicine is made from the bark.

Maerua parvifolia Pax (Liengme 229)
nongonongo

The roots are used for making medicine, the purpose of which is uncertain.

Manihot utilissima Pohl*
ntusumbulu

This is occasionally cultivated.

Maytenus heterophylla (Eckl. & Zeyh.) N. Robson
(Liengme 48)
xihlangwa/xilangwa

Spoons and stirrers, called 'rifeto', are sometimes made from the wood. It is also used as firewood.

Melia azedarach L.*
xifiringoma

This exotic provides roof poles and fence-posts. It is only common in the moister western parts of the study area, where it has become naturalized in disturbed areas.

Mimusops zeyheri Sond. (Liengme 64)
mibubulu; mpfuxane; nhlantswa

The fruit is eaten.

Oncoba spinosa Forssk.
mbhovu; nchowana; tongwana

The dried fruits of this tree are used in making ankle-rattles worn at dances.

Opuntia ficus-indica (L.) Mill.*
mudoro

The fruit of this naturalized exotic is often eaten. The plant is widespread in the Lowveld Sour Bushveld.

Ozoroa engleri R. & A. Fernandes
xinungumafi

The wood burns well and it is specially selected when a hot fire is required.

Ozoroa reticulata (Bak. f.) R. & A. Fernandes subsp. *reticulata* var. *reticulata* (Liengme 169)
xinungu; mfute

Besides being used as firewood, this species also has a medicinal use: the roots and bark are used to make a purgative.

Pappea capensis Eckl. & Zeyh. (Liengme 171)
gulaswimbi; guvaswivi; xikwakwaxu

This tree sometimes produces large crops of its small fruit. The pulp of the fruit, which is quite sour, is eaten.

Parinari curatellifolia Planch. ex Benth. subsp. *mobola* (Oliv.) R. Grah.
mbulwa

The fruit tastes pleasant and is eaten in fairly large quantities. It generally ripens in late winter or early spring. Dried, the fruit keeps for several months.

Peltophorum africanum Sond.
ndzedwe; ndzhuva; nhlanhlanu

The wood is used for fence-posts and for carving bowls. It occurs in the Lowveld Sour Bushveld.

Pennisetum americanum (L.) Leeke subsp. *americanum**
mahoba

Millet is cultivated in most parts of Gazankulu. The grain is mostly used in the brewing of traditional beer.

Phaseolus sp.*
nyawa

Beans are cultivated in some areas.

Phoenix reclinata Jacq.
mbovu; ncindzu; nchindu-lisundu

This palm occurs scattered along streams in the Lowveld parts of the study area. An alcoholic beverage used to be made from the fruit, but it is uncertain if this is still done. Mats are made from the rachis of the leaf. The rachis is split in four and the pieces are tied or threaded together with twine.

Phragmites mauritianus Kunth (Liengme 163)
rihlanga

This reed is common along most rivers. It is used to build palisades, in roof construction and as an underlayer in thatching.

Phyllanthus reticulatus Poir.
swatima lowutsongo; nthethenya

The fruit is eaten.

Phyllanthus verrucosus Thunb. (Liengme 218)
nsangasa

The fruit is eaten.

Physalis peruviana L.* (Liengme 2)
malanguti (fruit (pl.))

This exotic has become naturalized in the moister areas of Gazankulu (Lowveld Sour Bushveld). Its edible fruit is popular with all.

Piliostigma thonningii (Schumach.) Milne-Redh. (Liengme 40)
nkokotso/nkolokotso; xidengana

This tree occurs occasionally in the Lowveld Sour Bushveld. The large pods are sometimes fed to cattle.

Pittosporum viridiflorum Sims
mphatakhamelo

Spoons are carved from the soft white wood.

Plectranthus esculentus N.E. Br.
nthada/ntheda

The tubers of this herbaceous plant are eaten.

Pluchea dioscorides (L.) DC.
bvimba

This is another plant whose name indicates its use. The leaves were used as a cork or stopper to close bottles, pots or jars. This practice is seldom heard of

today. The Tsonga name is derived from the verb 'bvimba', meaning 'seal with a lid'.

Pseudolachnostylis maprouneaefolia Pax (*Liengme* 140)
nxojowa

The wood is used for carving spoons.

Ptaeroxylon obliquum (Thunb.) Radlk.
ndazi; ndzari

Various utensils and other items are carved from the wood. The tree occurs occasionally, usually near rivers.

Pterocarpus angolensis DC. (*Liengme* 110)
mvhangazi; murotso; ntsonde

This tree, commonly known as kiat, has beautiful, hard but workable wood from which furniture, bowls, plates, spoons and carved objects of art are made. It is a favoured wood for making items for sale as curios. The tree is protected in the homeland and the wood is not easily obtainable. The bark is used in veterinary medicine. It is believed to cure limping if it is placed on the injured part of the beast.

Pterocarpus rotundifolius (Sond.) Druce subsp. *rotundifolius* (*Liengme* 179)
mpyalelangala; muhadamba; muyataha; ndleve ya ndlopfu; nxelana/nxelela

Hoe handles are made from wood, which is strong but not very durable. The tree occurs in the Arid Lowveld.

Pterolobium stellatum (Forssk.) Gmel.
rikatsi/rikatsu

This is sometimes planted as a living fence, providing an impenetrable barrier.

Rhoicissus digitata (L.f.) Gilg & Brandt (*Liengme* 234)
mbhesa/mphesa; mbhezana

The roots of this climber are used in the preparation of a stomach medicine.

Ricinus communis L.*
nhlampfurha

Oil is extracted from the seeds and used for a number of purposes. It is rubbed on the skin and is also used as ear-drops. The plant is a weedy exotic, common in the Lowveld Sour Bushveld. The Tsonga name is derived from the word 'mafurha' which means 'fat, oil or grease'.

Saccharum officinale L.*
mova

Sugar-cane is cultivated in gardens in some parts of the study area.

Sansevieria hyacinthoides (L.) Druce (*Liengme* 187)
xikwenga

A fibre is obtained from the leaf, which was once used as a thread for sewing and for making string. *Agave* fibre has replaced this in most areas.

Sarcostemma viminalis (L.) R. Br. (*Liengme* 119)
neta

This is a fairly common plant in the Arid Lowveld and the Mopane Veld, generally growing over trees. The milky sap is added to food given to cows in the belief that it will make them produce more milk.

Scirpus inclinatus (Del.) Aschers. & Schweinf. (*Liengme* 8, 198)
mixaka; vungwane

This plant occurs along rivers and streams in the Lowveld Sour Bushveld and is used to make mats of inferior quality to those made from *Cyperus latifolius*.

Sclerocarya caffra Sond.
nkanye

This widely distributed, common tree has many uses. The wood is not very hard when fresh and is fairly easily workable, being made into spoons, mortars, pestles, bowls and plates, drums and cattle yokes. The wood hardens as it dries and is quite durable. It seems that only male trees are cut. Female trees are spared because of the edible fruit they bear. The fruit falls off the tree and ripens on the ground during February/March. It is collected and taken home, eaten or used to make a beer called 'bukanye'. The pips are removed from the fruit by boiling it in water. The skin comes off and is discarded and the flesh can be separated from the pip. The pips are stored for use later and the flesh is usually eaten or allowed to ferment to make beer. The pips are stored until they dry, when they are cracked and the kernels removed. These are very tasty when roasted and are eaten by themselves or added to relishes. The marula tree is probably the most important wild fruit tree of the Tsonga. The bark and roots are used to make a cleansing medicine for the stomach.

Securinega virosa (Rosb. ex Willd.) Rax & K. Hoffm.
nhlangawume/nxangawume; nsangasa

The fruit is eaten by children. The flexible young branches are used as withies in building.

Setaria sp. (*Liengme* 168)
xihovane; xichakala; pundze

This is one of the grasses used for thatching in the traditional way.

Solanum incanum L. (*Liengme* 176)
ndzhulwane; nthuma yo kulu

This ruderal is often found around dwellings. The fruit is crushed and placed on the umbilical wound of a new-born baby until it heals.

Solanum panduraeforme E. Mey. (*Liengme* 173)
ndulwane/ndzhulwane; nthuma; rirhulwane

This ruderal has the same use as *Solanum incanum*.

Spilanthes mauritiana (Pers.) DC. (*Liengme* 147)
xixwene; xixwenelamhofu

The leaves are rubbed on mouth-ulcers in order to ease the pain.

Spirostachys africana Sond.
ndzopfuri; xilangamahlo

Bowls, ornaments and stools are carved from the wood. The tree is not very common in the study area.

Sporobolus africanus (Poir.) Robyns & Tournay (*Liengme* 159)
muxikijane

This grass is sometimes used as thatch, but it is more often used to lash the thatch down onto the roof frame-work. It is also used to make items such as table-mats, sold as curios.

Strychnos madagascariensis Poir. (Liengme 113)
nkwakwa

This tree occurs occasionally in the area and is usually left standing in fields. The pulp of the fruit is edible. It can be eaten raw but is normally stamped into a flour and kneaded into cakes or made into a food called 'mpfuma'. The young branches are used as withies in building.

Strychnos spinosa Lam. (Liengme 15)
nhlala/nsala

The pulp of the fruit is eaten. Fresh pulp is sometimes added to milk to make it sour. The pulp is also added to mealies (*Zea mays*) that have been stamped and cooked.

Syzygium cordatum Hochst. (Liengme 49)
muhlwa/muthwa

This tree occurs along streams and rivers in the Lowveld Sour Bushveld. The fruit is eaten.

Tabernaemontana elegans Stapf (Liengme 206)
nkahla/nkahlwane

The wood is soft and is used for carving spoons. The pulp of the fruit is edible, but it is not certain to what extent it is eaten. The tree occurs in the north-western parts of the study area.

Tecomaria capensis (Thunb.) Spach.
khujana

The young branches of this shrub are used in the manufacture of baskets. The rims of baskets made from *Acacia ataxacantha* wood strips consist of two rings of wood bound to the body of the basket. The inner of these two rings is made from the wood of this shrub.

Terminalia sericea Burch. ex DC. (Liengme 32)
mugosi; nkonolo/nkonola/nkohono

The wood of this tree is used for making door-frames, pestles, spoons and a number of other articles. The root is used to make an emetic.

Themeda triandra Forssk.
kondze; mbvume; xivopfu

This is one of the grasses used for thatching in the traditional way.

Trichilia emetica Vahl (Liengme 101, 209)
nkuhlu

Oil is extracted from the seeds and used for medicinal purposes. The pulp of the fruit is said to be edible. The wood is one of those from which a certain type of musical bow is made.

Turraea obtusifolia Hochst. (Liengme 125)
mbhovane

Herbalists use the crushed leaves and fruit of this shrub to make an enema.

Tylosema fassoglensis (Schweinf.) Torre & Hillc.
(Liengme 47)
nthamula

The roots of this creeper yield a brown dye when crushed in water. The twigs are used in basket-making and the seeds are roasted and eaten.

Vangueria infausta Burch. (Liengme 99)
mpfilwa; ntswila

This small tree occurs occasionally in the Lowveld Sour Bushveld. The fruit is eaten and the pulp of the fruit is sometimes added to milk to make it sour.

Xeromphis obovata (Hochst.) Keay
mutungababara

The fruit of this Arid Lowveld shrub is used to make an emetic. It is believed that the crushed roots, if given to a patient, drive out demons.

Xerophyta retinervis Bak.
sirudzu

This plant occurs on rocky hills and ridges in the lowveld areas. The plants are tied together to make brooms and are also used as fuel for firing pots.

Ximenia americana L. var. *microphylla* Welw.
(Liengme 231, 225)
musomuwu; ntsengele; ntsengele yantsongo

The fruits are eaten. The plant occurs on hills in the Arid Lowveld and Mopane Veld.

Ximenia caffra Sond. var. *caffra* (Liengme 114, 230)
This species also has fruit which are eaten.

Zanthoxylum capense (Thunb.) Harv. (Liengme 58)
khinungumorupa; manhungwane; nugani; xirho-mbehlela

The roots are cooked in the water to make a medicine for colds. The leaves are crushed and put in the nose as a decongestant.

Zea mays L.*
mavele

This is the most important crop cultivated by the Tsonga. It forms the basis of their diet in the form of meal and on the cob. The crop is cultivated all over Gazankulu, even in dry areas. The Tsonga name given here is actually the word used to describe any grain crop. There are several other names given to parts of the plant or referring to different stages of its growth. For example, 'nan'wany'i' is a very young plant; 'mphovo' is an immature ear of maize.

Ziziphus mucronata Willd. subsp. *inucronata*
ncecenyi; mphasamhala

This is a widespread tree, quite common in the Arid Lowveld. The fruit is eaten, mostly by children.

DISCUSSION

Food plants

Of the wild plants listed as being sources of edible fruit or leaves it would seem that the most important are:

Sclerocarya caffra (fruit)
Strychnos species (fruit)
Diospyros inespiliformis (fruit)
Parinari curatellifolia subsp. *mobola* (fruit)
Bidens pilosa (leaves)
Bidens pilosa species (leaves), and
Amaranthus thunbergii (leaves).

These are widely and commonly used. The last three are used in relishes/sauces which are eaten with maize meal (*Zea mays*), the staple food.

The fruit of *Sclerocarya* is highly prized, being used to make a beer called 'bukanye'. *Diospyros*,

Strychnos and *Parinari* fruits are important as they ripen in late winter and early spring, when cultivated foods are scarce. *Strychnos inadagascariensis* fruit is especially important in times of drought, as the dried pulp can keep for months.

Most of the other edible fruits of the study area are small and mostly eaten by children, sometimes by adults.

The Tsonga diet consists mainly of cultivated food plants. *Zea mays* is the staple food, being widely cultivated. *Pennisetum americanum* subsp. *americanum* (millet) is also cultivated, mainly to provide malt for brewing beer.

Common vegetable crops include:

sweet potato — *Ipomoea batatas*
pumpkin — *Cucurbita pepo*
squash — *Cucurbita maxima*
beans — *Phaseolus* sp.
peanuts — *Arachis hypogaea*
calabash — *Lagenaria siceraria*

The pigeon pea, *Cajanus cajan*, cassava, *Manihot utilisima* and tomatoes, onions, spinach and leeks are less frequently cultivated. Sugar-cane, *Saccharum officinale*, is also grown in some areas.

The Tsonga generally cook once a day and the main meal consists of mealie meal (*Zea mays* meal), 'vuswa', and savoury, 'xixexo'. The latter can be vegetables or sauce (consisting of wild leaves, spinach, peanuts, marula nuts, beans or any other cultivated vegetable) or meat. Flying-ants, grasshoppers and mopane worms are also eaten.

Tsonga alcoholic beverages are made from marula fruit, sugar-cane, maize meal, sorghum and millet, some being more potent than others.

Building (including thatching)

The traditional Tsonga hut of recent times consists of wood and mud walls and a conical roof consisting of a wooden framework covered with thatch. The roof is often supported by poles outside the perimeter of the walls. A hut requires a fair amount of both wood, in the form of poles, sticks and wattles, and grass. Fences and stockades are often made entirely out of wood and large quantities of wood are used in these structures. In the remoter areas all building timber is obtained from the indigenous vegetation, whilst in less remote areas with access to plantations, *Eucalyptus* is often used.

The traditional method of thatching roofs is to tie grass into mats called 'makenye'. Grass species such as *Theineta triandra*, *Heteropogon contortus* or *Setaria* spp. are used. The mats are rolled up and stacked until the roof is ready to be thatched. Then the mats are laid out on the roof, starting at the lower edge of the roof, and secured.

This thatching is of inferior quality to that produced by the method of reverse-thatching, a less common method of thatching in Gazankulu. The reason for this latter type of thatching not being common is that it requires grass species like *Hyperthelia dissoluta* and *Hyparrhenia* spp. and these hardly occur in the Arid Lowveld and Mopane Veld vegetation types which cover the greater part of Gazankulu. They do occur in the Lowveld Sour Bushveld and reverse-thatched roofs are somewhat commoner here. Good thatch-grass can be bought from other areas by those who can afford it.

Reverse-thatched roofs are far more permanent than the others, lasting up to 30 years and longer.

The traditional thatched roofs need replacing every few years.

Much grass is required to thatch a single roof and the women may walk many kilometres to collect sufficient grass. The women collect and clean the thatch, but it is the men who do the thatching.

Medicinal plants

Much of the information collected on medicinal uses of plants was obtained from a herbalist, Mr Mondlane. Some of his cures are commonly known amongst the Blacks; for example, a stomach medicine made from the roots of *Capparis tomentosa*. Many of his medicines appear not to have been previously recorded. Eye-drops made from *Aptosium lineare* and a cure for broken bones made from a *Leonotis* sp. are two examples.

This herbalist had a wide knowledge of the medicinal uses of plants and knew as well that some plants only grew in certain parts of Gazankulu. To collect all the plants he needed he travelled quite long distances. Besides the specialist knowledge of herbalists, the people also have a knowledge of medicinal plants. For example, *Clenatis brachiata* is commonly used to cure colds and headaches. Often the people know that a plant is used by the 'doctors' for curing a condition, but do not know how it is used because that is the 'doctor's' secret.

Utensils and basketry

Although some of the traditional utensils have been replaced by modern goods available at any trading store, many are still in very wide use. Mortars and pestles as well as winnowing baskets are to be seen everywhere, as are wooden spoons and stirrers and conical baskets. Calabashes still have their traditional use in beer drinking. Utensils which are bought from a store are usually tin/enamel mugs, basins and plates, buckets and 3-legged cast-iron pots. Basket-making is one craft which has not died out completely, having been stimulated in some parts by demand from tourists. Baskets are of various types and are made from several materials. Conical baskets are used for storing mealie meal, beans and other food. These are made from *Cocculus hirsutus* stems or plaited grass culms, wound around in circles one above the other, each bound to the one below by *Cocculus* stems split in half. Twilled baskets are made from thin strips of *Acacia ataxacantha* wood or *Hyphaene natalensis* fronds. The latter plant is, however, scarce and baskets made from it are now rare. Twilled baskets include the shallow, saucer-like winnowing baskets, spherical baskets with or without lids and 'wallets'. Beer strainers are also twilled. The winnowing baskets and the spherical baskets are common. The body of these baskets is made from *Acacia ataxacantha* wood strips. The rim is made from wood of *Brachylaena discolor*, *Tecomaria capensis*, *Grewia* spp. or *Lannea stuhlmannii*, and is bound to the body with stems of *Dioscorea cotinifolia*. A third type of basket is made predominantly from a plant called 'staf' in Tsonga; a climber identified as *Secamone alpinii*.

Tsonga botany

Junod (1962), in a brief discussion on Tsonga botany, noted the following:

- (1) that the notion of 'genus' is present in Tsonga taxonomy;
- (2) that species are distinguished by mentioning their habitat or sex; and

(3) diminutives are used to distinguish species.

All three of these aspects were also noted by the researcher. For example, *Faurea saligna* and *F. speciosa*, easily distinguishable by their different leaves, have the same Tsonga name, indicating that they are in the same 'genus' in Tsonga taxonomy. There are several *Grewia* spp. which fall under the name 'nsihana'. Some of the species have other names too, but 'nsihana' seems to be a generic name. Tsonga genera do not necessarily correspond with ours. With regard to the second of the points made by Junod, the fig, *Ficus sycamorus*, is called 'nkuwa' and is distinguished from *F. soldanella*, which is called 'nkuwa ya ntsava', ('ya ntsava' meaning 'of the hill') by the addition of the habitat to the name. *Epaltes gariepina* and *Blumea aurita* have the same name 'munywane' but are distinguished as being female and male forms respectively. Diminutives were noted as well. For example, *Berchemia discolor* is 'nyiri' and *B. zeyheri* is 'nyiyani', 'the little 'nyiri'. Diminutives are also indicated by the suffix '-ntsongo' to the plant name, as in the case of *Phyllanthus reticulatus* which is called 'swatima lowutsonga', 'the little 'swatima'. *Bridelia mollis* is 'swatima'.

A much more complete list of Tsonga plant names and their uses is necessary in order to make a more detailed analysis of Tsonga taxonomy.

UITTREKSEL

'n Studie is in 'n deel van die Tsonga-tuisland, Gazankulu, onderneem om plante wat deur hierdie mense gebruik word te identifiseer. 'n Lys van Tsonga-plantname is met behulp van 'n Tsonga-Engelse woordeboek opgestel as basis vir die studie. Die gebruike van bykans 200 plante vir, onder andere, medisinale doeleindes, voedsel, boumateriaal, vuurmaakhout, huishoudelike gereedskap, implemente, implemente en speelgoed is aangeteken. Hierdie inligting word in die vorm van 'n verklarende lys van die plante aangebied. Dit word gevolg deur 'n bespreking van sommige van die meer belangrike gebruike. Sommige aspekte van Tsonga taksonomie word kortliks bespreek en met voorbeelde toegelig.

REFERENCES

- ACOCKS, J. P. H., 1975. Veld types of South Africa. *Mem. bot. Surv. S. Afr.* No. 40.
- CUENOD, R., 1976. *Tsonga-English Dictionary*. Johannesburg: Sasavona.
- JUNOD, H. A., 1962. *The life of a South African tribe*. New York: University Books Inc.
- PALMER, E. & PITMAN, N., 1972. *Trees of southern Africa*. Cape Town: A. A. Balkema.
- SHAW, E. M., 1974. Material culture. In W. D. Hammond-Tooke, *Bantu-speaking peoples of southern Africa*. Ed. 2, pp. 85-126. London: Routledge & Keagen Paul.
- VAN WARMELO, N. J., 1974. The classification of cultural groups. In W. D. Hammond-Tooke, *Bantu-speaking peoples of southern Africa*. Ed. 2, pp. 58-84. London: Routledge & Keagen Paul.
- VAN WYK, P., 1972. *Trees of the Kruger National Park*. Cape Town: Purnell.
- WATT, J. M., & BREYER-BRANDWIJK, M., 1962. *Medicinal and poisonous plants of southern and eastern Africa*. Ed. 2. London: E. & S. Livingstone.

APPENDIX A

INDEX OF PLANT USES

Baskets: *Acacia ataxacantha*, *Brachylaena discolor* subsp. *transvaalensis*, *Cocculus hirsutus*, *Dioscorea cotinifolia*, *Grewia flavescens* var. *flavescens*, *Hyphaena natalensis*, *Lannea stuhlmannii*, *Tecomaria capensis*, *Tylosema fassoglensis*.

Beads: *Bauhinia galpinii*.

Beverage (Alcoholic): *Garcinia livingstonei*, *Pennisetum americanum* subsp. *americanum*, *Phoenix reclinata*, *Sclerocarya caffra*.

Beverage (Non-Alcoholic): *Athrixia phylicoides*.

Buildings (Timber): *Acacia caffra*, *A. nigrescens*, *Adina microcephala* var. *galpinii*, *Azafia quanzensis*, *Colophospermum mopane*, *Combretum apiculatum* subsp. *apiculatum*, *C. hereroense* subsp. *hereroense* var. *hereroense*, *C. imberbe*, *Cussonia spicata*, *Diospyros mespiliformis*, *Dombeya rotundifolia* var. *rotundifolia*, *Eucalyptus* spp., *Faurea saligna*, *F. speciosa*, *Melia azedarach*, *Terminalia sericea*.

Building (Withies): *Antidesma venosum*, *Brachylaena discolor* subsp. *transvaalensis*, *Catha edulis*, *Combretum hereroense* subsp. *hereroense* var. *hereroense*, *Cordia ovalis*, *Diospyros natalensis* subsp. *natalensis*, *Euclea crispa* var. *crispa*, *Ficus capreaefolia*, *Securinega virosa*, *Strychnos madagascariensis*.

Cordage: *Acacia karroo*, *Colophospermum mopane*, *Dombeya burgessiae*, *Ficus burkei*, *Hibiscus cannabinus*, *Lannea discolor*, *L. stuhlmannii*.

Dye: *Lannea stuhlmannii*, *Tylosema fassoglensis*.

Fencing: (including palisades) *Acacia caffra*, *Bambusa* sp., *Colophospermum mopane*, *Combretum apiculatum* subsp. *apiculatum*, *Diospyros natalensis* subsp. *natalensis*, *Erythrina lysistemon*, *Peltophorum africanum*, *Phragmites mauritanus*.

Fibre: *Agave* spp., *Artabotrys brachypetalus*, *Gossypium herbaceum* var. *africanum*, *Sansevieria hyacinthoides*.

Fodder: *Piliostigma thonningii*.

Food: *Adansonia digitata*, *Amaranthus thunbergii*, *Annona senegalensis*, *Antidesma venosum*, *Arachis hypogaea*, *Artabotrys brachypetalus*, *Bequaertiodendron magalismontanum*, *Berchemia discolor*, *Bidens pilosa*, *Bridelia micrantha*, *B. mollis*, *Cajanus cajan*, *Capsicum frutescens*, *Carissa edulis*, *Cassia occidentalis*, *Cephalanthus natalensis*, *Colocasia antiquorum*, *Combretum paniculatum* subsp. *microphyllum*, *Corchorus confusus*, *C. tridens*, *Cordia ovalis*, *Cucumis melo*, *Cucurbita maxima*, *C. pepo*, *Diospyros mespiliformis*, *D. natalensis* subsp. *natalensis*, *Euclea divinorum*, *Ficus capensis*, *F. capreaefolia*, *F. soldanella*, *F. sonderi*, *F. stuhlmannii*, *F. sycamorus*, *Flacourtia indica*, *Garcinia livingstonei*, *Grewia flavescens* var. *flavescens*, *G. flavescens* var. *olukondae*, *G. occidentalis*, *Hexalobus monoperlati*, *Ipomoea batatas*, *Lagenaria siceraria*, *Landolphia kirkii*, *Lannea discolor*, *L. edulis*, *L. stuhlmannii*, *Lantana rugosa*, *Manihot utilisima*, *Mimusops zeyheri*, *Opuntia ficus-indica*, *Pappea capensis*, *Parinari curatellifolia* subsp. *mobola*, *Pennisetum americanum* subsp. *americanum*, *Phaseolus* spp., *Phyllanthus reticulatus*, *P. verrucosus*, *Physalis peruviana*, *Plectranthus esculentus*, *Saccarum officinale*, *Sclerocarya caffra*, *Securinega virosa*, *Strychnos madagascariensis*, *S. spinosa*, *Syzygium cordatum*, *Tabernaemontana elegans*, *Trichilia emetica*, *Tylosema fassoglensis*, *Vangueria infausta*, *Ximenia americana* var. *microphylla*, *X. caffra* var. *caffra*, *Zea mays*, *Zizyphus mucronata* subsp. *mucronata*.

Food (Famine): *Kigelia africana*.

Fuel: *Acacia ataxacantha*, *A. caffra*, *A. davyi*, *A. gerrardii* var. *gerrardii*, *A. karroo*, *A. sieberana* var. *woodii*, *A. tortilis* subsp. *heteracantha*, *Albizia harveyi*, *Allophylus decipiens*, *Brachylaena discolor* subsp. *transvaalensis*, *Colophospermum mopane*, *Combretum erythrophyllum*, *Dichrostachys cinerea* subsp. *africana*, *Dovyalis zeyheri*, *Faurea saligna*, *F. speciosa*, *Ficus capensis*, *Maytenus heterophylla*, *Ozoroa engleri*, *O. reticulata* subsp. *reticulata* var. *reticulata*, *Xerophyta retinervis*.

Furniture: *Bolusanthus speciosus*, *Burkea africana*, *Faurea saligna*, *F. speciosa*.

Gaines and Toys: *Aloe davyana*, *Annona senegalensis*.

Implements and utensils: *Acacia nigrescens*, *Adina microcephala* var. *galpinii*, *Albizia versicolor*, *Berchemia discolor*, *Cassine transvaalensis*, *Colophospermum mopane*, *Combretum apicula-*

tum subsp. apiculatum, *C. imberbe*, *Commiphora pyracanthoides*, *Diospyros mespiliformis*, *Dombeya rotundifolia* var. *rotundifolia*, *Heteropyxis natalensis*, *Lagenaria siceraria*, *Lippia javanica*, *Maytenus heterophylla*, *Peltophorum africanum*, *Pittosporum viridiflorum*, *Pseudolachnostylis maprouneaeifolia*, *Ptaeroxylon obliquum*, *Pterocarpus angolensis*, *P. rotundifolius* subsp. *rotundifolius*, *Sclerocarya caffra*, *Spirostachys africanus*, *Tabernaemontana elegans*, *Terminalia sericea*, *Xerophyta retinervis*.

Implement handles: *Acacia ataxacantha*, *Berchemia discolor*, *Bolusanthus speciosus*, *Cassine transvaalensis*, *Combretum apiculatum* subsp. *apiculatum*, *C. hereroense* subsp. *hereroense* var. *hereroense*, *Commiphora pyracanthoides*.

Living fences and hedges: *Dodonea viscosa* var. *viscosa*, *Erythrina lysistemon*, *Pterolobium stellatum*.

Magic: *Asparagus virgatus*, *Gardenia spatulifolia*, *Kigelia africana*, *Sarcostemma viminale*.

Mats: *Cyperus latifolius*, *C. sexangularis*, *Phoenix reclinata*, *Scirpus inclinatus*, *Sporobolus africanus*.

Medicine: *Albizia versicolor*, *Aptosimum lineare*, *Artabotrys brachypetalus*, *Asclepias burchellii*, *Balanites maughamii*, *Blumea aurita*, *B. gariepina*, *Bridelia micrantha*, *Capparis fascicularis* var. *fascicularis*, *C. tomentosa*, *Clematis brachiata*, *Croton megalobotrys*, *Cryptolepis capensis*, *Cyphostemma humile* subsp. *humile*, *Epaltes gariepina*, *Gnidia rubescens*, *Leonotis* sp., *Lippia javanica*, *Lonchocarpus capassa*, *Maerua angolensis*, *M. parvifolia*, *Rhoicissus digitata*, *Ricinus communis*, *Sclerocarya caffra*, *Solanum incanum*, *S. panduraeforme*, *Spilanthes mauritiana*, *Terminalia sericea*, *Trichilia emetica*, *Turraea obtusifolia*, *Xeromphis obovata*, *Zanthoxylum capense*.

Musical instruments (including drums): *Balanites maughamii*, *Calodendron capense*, *Commiphora pyracanthoides*, *Cordia grandicalyx*, *Grewia flavescens* var. *flavescens*, *Oncoba spinosa*, *Sclerocarya caffra*, *Trichilia emetica*.

Oil: *Jatropha curcas*, *Ricinus communis*, *Trichilia emetica*.

Plug: *Pluchea dioscorides*.

Shade trees: *Adina microcephala* var. *galpinii*, *Albizia harveyi*, *A. versicolor*, *Cassia abbreviata* subsp. *beareana*, *Ekebergia capensis*.

Snuff: *Amaranthus cruentus*.

Soap (including shampoo): *Dicerocaryum zanguebarium* subsp. *zanguebarium*.

Thatch: *Cymbopogon validus*, *Heteropogon contortus*, *Hyparrhenia dichroa*, *H. dregeana*, *H. hirta*, *H. rudis*, *H. tamba*, *Hyperthelia dissoluta*, *Phragmites mauritanus*, *Setaria* sp., *Sporobolus africanus*, *Themeda triandra*.

Veterinary medicine: *Pterocarpus angolensis*.

Woodcarving: *Albizia versicolor*, *Berchemia discolor*, *Bolusanthus speciosus*, *Cassine aethiopica*, *Combretum hereroense* subsp. *hereroense* var. *hereroense*, *Crossopteryx febrifugia*, *Dalbergia melanoxylon*, *Gardenia spatulifolia*, *Ptaeroxylon obliquum*, *Pterocarpus angolensis*, *Spirostachys africanus*.

guvazwivi
guxe
guxe

K
khalavatl
khawa
khinungumorupa

khujana

kofi yanhova
kondze
kotoni
kumbekumbe

L
lumanyama

M (Ma-)
maamba
mahlanganiso
mahoba

malanguti
manga
manhungwane

mavele

(Mb--Mo-)
mbhandzu/mbhandzwa
mbhesa/mbhesa
mbhesu/mbhesvi
mbhesana
mbhimbi/mhimbi
mbhovane
mbhovhu

mbhovu
mbikanyaka

mbimba
mbomu

mbovu
mbulwa

mbvinyaxhloka
mbvume
mbvuvu/mvuvu

mfute

mgula

mgupa

mhangani

mibululu
mikoka
mindzere/mundzere/ndzerhe

mischa

mixaka

mola/molani
molela
mondzo
mova
mowu/muwu

(Mp--Mt-)
mpfalambati

mpfilwa
mpfimbahongoni

mpfungu/mpfungurhu
mpfunta

mpfunte-mpfunte

Pappea capensis Eckl. & Zeyh.
Corchorus confusus Wild
Corchorus tridens L.

Cucurbita maxima Duch.
Capparis tomentosa Lam.
Zanthoxylum capense (Thunb.) Harv.
Tecomaria capensis (Thunb.) Spach
Athrixia phlycoides DC.
Themeda triandra Forssk.
Asclepias burchellii Schltr.
Bridelia mollis Hutch.

Cassia abbreviata Oliv. subsp. *beareana* (Holmes) Brenan

Clematis brachiata Thunb.
Leonotis sp.
Pennisetum americanum (L.) Leeke subsp. *americanum*
Physalis peruviana L.
Arachis hypogaea L.
Zanthoxylum capense (Thunb.) Harv.
Zea mays L.

Lonchocarpus capassa Rolfe
Rhoicissus digitata Gilg & Brandt
Albizia versicolor Welw. ex Oliv.
Rhoicissus digitata Gilg & Brandt
Garcinia livingstonei T. Anders.
Turraea obtusifolia Hochst.
Calodendron capense (L.f.) Thunb.
Oncoba spinosa Forssk.
Dombeya rotundifolia (Hochst.) Planch. var. *rotundifolia*
Combretum imberbe Wawra
Hexalobus monopetalus (A. Rich.) Engl. & Diels
Phoenix reclinata Jacq.
Parinari curatellifolia Planch. ex Benth. subsp. *mobola* (Oliv.) R. A. Grah.
Acacia caffra (Thunb.) Willd.
Themeda triandra Forssk.
Combretum erythrophyllum (Burch.) Sond.
Ozoroa reticulata (Bak. f.) R. & A. Fernandes subsp. *reticulata* var. *reticulata*
Diospyros mespiliformis Hochst. ex A. DC.
Combretum erythrophyllum (Burch.) Sond.
Aloe davyana Schoenl. var. *davyana*
Mimusops zeyheri Sond.
Clematis brachiata Thunb.
Bridelia micrantha (Hochst.) Baill.
Gossypium herbaceum L. var. *africanum* (Watt) J. B. Hutch. & Ghose
Scirpus inclinatus (Del.) Aschers. & Schweinf. ex Boiss.
Albizia harveyi Fourn.
Albizia harveyi Fourn.
Combretum imberbe Wawra
Saccharum officinale L.
Adansonia digitata L.

Antidesma venosum E. Mey. ex Tul.
Vangueria infausta Burch.
Bolusanthus speciosus (H. Bol.) Harms
Kigelia africana (Lam.) Benth.
Combretum paniculatum Vent. subsp. *microphyllum* (Klotzsch) Wickens
Combretum paniculatum Vent. subsp. *microphyllum* (Klotzsch) Wickens

APPENDIX B

INDEX OF TSONGA PLANT NAMES

TSONGA NAME	BOTANICAL NAME
B	
bvimba	<i>Pleuchea dioscorides</i> DC.
C	
chipachipachane chochelamandleni yantsongo	<i>Dovyalis zeyheri</i> (Sond.) Warb. <i>Combretum paniculatum</i> Vent. subsp. <i>microphyllum</i> (Klotzsch) Wickens
D	
deke	<i>Cymbopogon validus</i> (Stapf) Stapf ex Burtt Davy
dinda/dindza	<i>Dicerocaryum zanguebarium</i> (Lour.) Merr.
G	
gapi gawana gulaswimbi	<i>Ipoioea batatas</i> (L.) Lam. <i>Cucurbita maxima</i> Duch. <i>Pappea capensis</i> Eckl. & Zeyh.

mpfluxane	<i>Minusops zeyheri</i> Sond.	nchuchungwa	<i>Lannea edulis</i> (Sond.) Engl.
mphasamhala	<i>Zizyphus mucronata</i> Willd.	nchugulu	<i>Carissa edulis</i> Vahl
	subsp. <i>mucronata</i>	nchuguru/ntshuguru	<i>Carissa edulis</i> Vahl
mphata	<i>Brachylaena discolor</i> DC. subsp.	ncindzu	<i>Phoenix-reclinata</i> Jacq.
	<i>transvaalensis</i> (Phill. & Schweick.) J. Paiva	nciwana	<i>Grewia flavescens</i> Juss. var. <i>flavescens</i>
mphatakhamele	<i>Pittosporum viridiflorum</i> Sim	ndazi	<i>Ptaeroxylon obliquum</i> (Thunb.) Radlk.
mphatakhwari	<i>Antidesina venosum</i> E. Mey. ex Tul.	ndhenga/ndzhenga	<i>Dichrostachys cinerea</i> (L.) Wight & Arn. subsp. <i>africana</i> Brenan & Brummitt
mphovo	<i>Zea mays</i> L. (immature plant)	ndivata/ndzivata	<i>Lannea stuhlmannii</i> (Engl.) Engl.
mpon'wana	<i>Cordia ovalis</i> R. Br. ex DC.	ndlejane	<i>Cyphostemum humile</i> (N.E. Br.) Desc. ex Wild & Drumm. subsp. <i>humile</i>
mpotsa/mpoza	<i>Combretum apiculatum</i> Sond.	ndleve yandlopfu	<i>Pterocarpus rotundifolius</i> (Sond.) Druce subsp. <i>rotundifolius</i>
	subsp. <i>apiculatum</i>	ndlulamithi	<i>Eucalyptus</i> spp.
mpotsa/mpoza	<i>Combretum hereroense</i> Schinz	ndodzi	<i>Cajanus cajan</i> (L.) Millsp.
	subsp. <i>hereroense</i> var. <i>hereroense</i>	ndulwane/ndzhulwane	<i>Solanum panduraeforme</i> E. Mey.
mpulu	<i>Burkea africana</i> Hook.	ndzari	<i>Ptaeroxylon obliquum</i> (Thunb.) Radlk.
mpyalelangala	<i>Pterocarpus rotundifolius</i> (Sond.) Druce subsp. <i>rotundifolius</i>	ndzedze	<i>Peltophorum africanum</i> Sond.
mtlele	<i>Cordia ovalis</i> R. Br. ex DC.	ndzhopfa/ndzompfa/ndzopfa	<i>Annona senegalensis</i> Pers.
(Mu--Mv-) mucece	<i>Albizia versicolor</i> Welw. ex Oliv.	ndzhulwane	<i>Solanum incanum</i> L.
mudodivisa	<i>Dodonaea viscosa</i> Jacq. var. <i>viscosa</i>	ndzhuva	<i>Peltophorum africanum</i> Sond.
mudoro	<i>Opuntia ficus-indica</i> (L.) Mill.	ndzololwane/nsululwani	<i>Albizia harveyi</i> Fourn.
muganukomu	<i>Lannea stuhlmannii</i> (Engl.) Engl.	ndzopfori	<i>Spirostachys africanus</i> Sond.
mugarasaka	<i>Combretum apiculatum</i> Sond.	Ndzundzuluka/nhundzuluka	<i>Ximenia caffra</i> Sond. var. <i>caffra</i>
	subsp. <i>apiculatum</i>	(Ne--Nj-) nembenembe	<i>Cassia occidentalis</i> L.
mugejo	<i>Cymbopogon validus</i> (Stapf) Stapf ex Burt Davy	neta	<i>Sarcostemma viminalis</i> (L.) R. Br.
mugosi	<i>Terminalia sericea</i> Burch. ex DC.	ngoka	<i>Acacia tortilis</i> (Forssk.) Hayne subsp. <i>heteracantha</i> (Burch.) Brenan
muhadamba	<i>Pterocarpus rotundifolius</i> (Sond.) Druce subsp. <i>rotundifolius</i>	nhlaba yafole	<i>Anaranthus cruentus</i> L.
muhlome/nhlume	<i>Adina microcephala</i> (Del.) Hiern var. <i>galpinii</i> (Oliv.) Hiern	nhlahle	<i>Cyperus sexangularis</i> Nees
muhlwa	<i>Syzygium cordatum</i> Hochst.	nhlala	<i>Strychnos cocculoides</i> Bak.
muhobadala	<i>Capparis fascicularis</i> DC. var. <i>fascicularis</i>	nhlala	<i>Strychnos spinosa</i> Lam.
mukurhu	<i>Donibeya burgessiae</i> Gerr. ex Harv.	nhlampfurha	<i>Ricinus communis</i> L.
mukorongwe	<i>Capparis tomentosa</i> Lam.	nhlampfurha yavalungu	<i>Jatropha curcas</i> L.
muluwa	<i>Acacia ataxacantha</i> DC.	nhlangawume/nxangawume	<i>Securinega virosa</i> (Roxb. ex Willd.) Pax & K. Hoffm.
mumbumumbu	<i>Lannea discolor</i> Engl.	nhlanhlana	<i>Peltophorum africanum</i> Sond.
munga	<i>Acacia karroo</i> Hayne	nhlangula/nhlohlangule	<i>Euclea divinorum</i> Hiern
mungu	<i>Landolphia kirkii</i> T.-Dyer	nhlantswa	<i>Minusops zeyheri</i> Sond.
munywane	<i>Blumea aurita</i> (L.f.) DC.	nhlata	<i>Ipomoea batatas</i> (L.) Lam.
munywane	<i>Epaltes gariepina</i> (DC.) Steetz	nhlulawumbe	<i>Ficus burkei</i> (Miq.) Miq.
muono	<i>Strychnos cocculoides</i> Bak.	nhlulawumbe	<i>Ficus stuhlmannii</i> Warb.
muqokolo	<i>Flacourtia indica</i> (Burm. f.) Merr.	nhlwehlwe	<i>Dicerocaryum zanguebarium</i> (Law.) Merr. (seed)
murhompfa	<i>Annona senegalensis</i> Pers.	njekejeke	<i>Cyperus latifolius</i> Poir.
murorongwe	<i>Garcinia livingstonei</i> T. Anders.	(Ni-) nkahlwa/nkahlwane	<i>Tabernaemontana elegans</i> Stapf
murhotso	<i>Pterocarpus angolensis</i> DC.	nkamba/nkhamba	<i>Bolusanthus speciosus</i> (H. Bol.) Harms
musengele	<i>Bambusa</i> sp.	nkanye/nkanyi	<i>Sclerocarya caffra</i> Sond.
musenje	<i>Cussonia spicata</i> Thunb.	nkaya/nkayi	<i>Acacia nigrescens</i> Oliv.
musuzwane	<i>Lippia javanica</i> L.	nkaya/nkayi	<i>Acacia caffra</i> (Thunb.) Willd.
muthango	<i>Faurea saligna</i> Harv.	nkenge	<i>Burkea africana</i> Hook.
muthango	<i>Faurea speciosa</i> (Welw.) Welw.	nkhayani	<i>Acacia caffra</i> (Thunb.) Willd.
muthondwa/ntondo	<i>Cephalanthus natalensis</i> Oliv.	nkhoihlwane	<i>Bolusanthus speciosus</i> (H. Bol.) Harms
muthuma	<i>Adina microcephala</i> (Del.) Hiern var. <i>galpinii</i> (Oliv.) Hiern	nkototso/nkolokotso	<i>Ptilostigma thonongii</i> (Schumacher.) M.-Redh.
mutwa	<i>Syzygium cordatum</i> Hochst.	nkombekwa/nkombelwa	<i>Crossopteryx febrifugia</i> (Afzel. ex G. Don) Benth.
mutungababara	<i>Xeromphis obovata</i> (Hochst.) Keay	nkonola/nkonolo/nkonono	<i>Terminalia sericea</i> Burch. ex DC.
muvale	<i>Erythrina lysistemon</i> Hutch.	nkowakowa	<i>Acacia sieberana</i> DC. var. <i>woodii</i> (Burt Davy) Keay & Brenan
muvambangoma	<i>Albizia versicolor</i> Welw. ex Oliv.	nkubatsebi	<i>Cassine transvaalensis</i> (Burt Davy) Codd
muveve	<i>Kigelia africana</i> (Lam.) Benth.	nkulu	<i>Trichilia emetica</i> Vahl
muvungwa	<i>Landolphia kirkii</i> T.-Dyer	nkungulatio/nkwangulatio	<i>Asparagus virgatus</i> Bak.
muwe	<i>Berberchia discolor</i> (Klotzsch) Hemsl.	nkuwa	<i>Ficus capensis</i> Thunb.
muxiji	<i>Bidens pilosa</i> L.	nkuwa	<i>Ficus sycanorus</i> L.
muxikijane	<i>Sporobolus africanus</i> (Poir.) Robyns & Tournay	nkuwa yatintsava	<i>Ficus soldanella</i> Warb.
muyataha	<i>Pterocarpus rotundifolius</i> (Sond.) Druce subsp. <i>rotundifolius</i>	nkwakwa	<i>Strychnos madagascariensis</i> Poir.
muyembe	<i>Annona senegalensis</i> Pers.	(Nn--Nt-) nombela	<i>Bequaertiodendron magalisuntanum</i> (Sond.) Heine & J. H. Hemsl.
muzugwane xihlahla	<i>Allophylus decipiens</i> Radlk.	nongonongo	<i>Maerua parvifolia</i> Pax
myhangazi	<i>Pterocarpus angolensis</i> DC.	nqokolo	<i>Flacourtia indica</i> (Burm. f.) Merr.
myhangazi wobasa	<i>Albizia versicolor</i> Welw. ex Oliv.	nsala	<i>Strychnos spinosa</i> Lam.
N (Na--Nd-) nala	<i>Hyphaene natalensis</i> Kunze	nsangasa	<i>Securinega virosa</i> (Roxb. ex Willd.) Pax & K. Hoffm.
necenyeni	<i>Zizyphus mucronata</i> Willd.		
ncenga	subsp. <i>mucronata</i>		
	<i>Dichrostachys cinerea</i> (L.) Wight & Arn. subsp. <i>africana</i> Brenan & Brummitt		
nchindu-lisundu	<i>Phoenix reclinata</i> Jacq.		
nchowana	<i>Oncoba spinosa</i> Forssk.		

nsasani	<i>Acacia tortilis</i> (Forssk.) Hayne subsp. <i>heteracantha</i> (Burch.) Brenan	rihlanga rikatsi/rikatsu	<i>Phragmites mauritianus</i> Kunth <i>Pterolobium stellatum</i> (Forssk.) Brenan
nsasani	<i>Acacia gerrardii</i> Benth. var. <i>ger- radii</i>	rindanga	<i>Lagenaria siceraria</i> (Molina) Standl.
nsidwa	<i>Dioscorea cotinifolia</i> Kunth	rihulwane	<i>Solanum panduraeforme</i> E. Mey.
nsihana	<i>Grewia flavescens</i> Juss. var. <i>flavescens</i>	risama	<i>Cyperus sexangularis</i> Nees
nsihana yokulu	<i>Grewia flavescens</i> Juss. var. <i>olukondae</i> (Schinz) Wild	risidwa	<i>Dioscorea cotinifolia</i> Kunth
nsihaphukuma	<i>Dombeya rotundifolia</i> (Hochst.) Planch. var. <i>rotundifolia</i>	risotse/rixoto	<i>Cocculus hirsutus</i> (L.) Diels
nsisimbana	<i>Erythrina lysistemon</i> Hutch.	rithadzi	<i>Catha edulis</i> (Vahl) Forsk. ex Endl.
ntamungu	<i>Carissa edulis</i> Vahl	ritiyi	<i>Ipomoea batatas</i> (L.) Lam.
nthada/ntheda	<i>Plectranthus esculentus</i> N.E. Br.	rupi	<i>Colocasia antiquorum</i> Schott.
nthamula	<i>Tylosea fassoglensis</i> (Schweinf.) Torre & Hillc.	S	
nthathasani	<i>Heteropyxis natalensis</i> Harv.	sirudzu	<i>Xerophyta retinervis</i> Bak.
nthethenya	<i>Phyllanthus reticulatus</i> Poir.	sitole	<i>Xerocephalus obovatus</i> (Hochst.) Keay
nthuma	<i>Solanum panduraeforme</i> E. Mey.	swatima	<i>Bridelia mollis</i> Hutch.
nthuma nkulu	<i>Solanum incanum</i> L.	swatima lowutsongo	<i>Phyllanthus reticulatus</i> Poir.
ntinta/ntita/ntiti	<i>Artabotrys brachypetalus</i> Benth.	swimbyambya	<i>Bridelia mollis</i> Hutch.
ntogwe	<i>Cordia grandicalyx</i> Oberm.	T	
ntoma	<i>Diospyros mespiliformis</i> Hochst. ex A. DC.	thyeka/thyeke	<i>Amaranthus thunbergii</i> Moq.
ntomantomane	<i>Diospyros natalensis</i> (Harv.) Brenan subsp. <i>natalensis</i>	tihove tavalungu	<i>Lantana rugosa</i> Thunb.
ntomantomane	<i>Euclea crispa</i> (Thunb.) Guerke var. <i>crispa</i>	tlongwe	<i>Hyparrhenia dichroa</i> (Steud.) Stapf.
ntsallala	<i>Gardenia spatulifolia</i> Stapf & Hutch.	tlongwe	<i>Hyparrhenia hirta</i> (L.) Stapf
ntsenga	<i>Hyparrhenia dichroa</i> (Steud.) Stapf	tongwaan	<i>Hyparrhenia tamba</i> (Hochst. ex Steud.) Anders. ex Stapf
ntsenga	<i>Hyparrhenia dregeana</i> (Nees) Stapf ex Stent	tshaman'hwati	<i>Oncoba spinosa</i> Forssk.
ntsenga	<i>Hyparrhenia hirta</i> (L.) Stapf	V	
ntsenga	<i>Hyparrhenia rudis</i> Stapf	viriviri	<i>Capsicum frutescens</i> L.
ntsenga	<i>Hyperthelia dissoluta</i> (Nees) Clayton	vucema	<i>Hyphaene natalensis</i> Kunze
ntsembyane/ntswembyane	<i>Hibiscus cannabinus</i> L.	vungwane	<i>Scirpus inclinatus</i> (Del.) Aschers. & Schweinf. ex Boiss.
ntsegele	<i>Ximenia americana</i> L. var. <i>microphylla</i> Welw. ex Oliv.	X	
ntsegele	<i>Ximenia caffra</i> Sond. var. <i>caffra</i>	xicalala	<i>Setaria</i> sp.
ntsegele yantsongo	<i>Ximenia americana</i> L. var. <i>microphylla</i> Welw. ex Oliv.	xicindzu	<i>Phoenix reclinata</i> Jacq.
ntsephukane	<i>Grewia occidentalis</i> L.	xidengana	<i>Piliostigma thonningii</i> (Schu- mach.) M.-Red.
ntshiriri/ntshwiriri	<i>Bauhinia galpinii</i> N. E. Br.	xifata/xifati	<i>Commiphora pyracanthoides</i> Engl.
ntsonde	<i>Pterocarpus angolensis</i> DC.	xifiringoma	<i>Melia azedarach</i> L.
ntsumbulu	<i>Manihot utilisima</i> Pohl	xigoya	<i>Cyperus latifolius</i> Poir.
ntswila	<i>Vangueria infausta</i> Burch.	xihlangwa/xilangwa	<i>Maytenus heterophylla</i> (Eckl. & Zeyh.) N. Robson
ntswukelane	<i>Grewia occidentalis</i> L.	xihovane	<i>Setaria</i> sp.
ntungufana	<i>Lippia javanica</i> L.	xikhavi	<i>Combretum hereroense</i> Schinz subsp. <i>hereroense</i> var. <i>here- roense</i>
(Nu--Nz-) nugani	<i>Zanthoxylum capense</i> (Thunb.) Harv.	xikukutsu	<i>Combretum apiculatum</i> Sond.
nulu	<i>Balanites maughamii</i> Sprague	xikwakwaxu	subsp. <i>apiculatum</i>
numanyama	<i>Cassia abbreviata</i> Oliv. subsp. <i>beareana</i> (Holmes) Brenan	xikwenga	<i>Pappea capensis</i> Eckl. & Zeyh.
nxakama	<i>Hexalobus inonopetalus</i> (A. Rich.) Engl. & Diels	xikwenga	<i>Sansevieria lycanthoides</i> (L.) Druce
nxanatsi	<i>Colophospermum inopane</i> (Kirk ex Benth.) Kirk ex J. Léonard	xilangamahlo	<i>Agave</i> sp.
nxelana/nxelela	<i>Pterocarpus rotundifolius</i> (Sond.) Druce subsp. <i>rotundifolius</i>	xilungwa	<i>Spirostachys africanus</i> Sond.
nxenhe	<i>Azelia quanzensis</i> Welw.	xilutana	<i>Heteropogon contortus</i> (L.) Beauv. ex Roem. & Schult.
nxojowa	<i>Pseudolachnostylis maprouneae- folia</i> Pax	xilutsi	<i>Cucurbita maxima</i> Duch.
nxunguxungu/nxungwezu- ngwe	<i>Croton megalobotrys</i> Müll. Arg.	xiluvathi	<i>Dalbergia melanoxylon</i> Guill. & Perr.
nyamarhi	<i>Ekebergia capensis</i> Sparrm.	ximahlomahlwane	<i>Dombeya rotundifolia</i> (Hochst.) Planch. var. <i>rotundifolia</i>
nyawa	<i>Phaseolus</i> sp.	ximapana	<i>Aptosimum lineare</i> Marloth & Engl.
nyiri/nyiyi	<i>Berchemia discolor</i> (Klotzsch) Hemsl.	ximbukanyi	<i>Cassia transvaalensis</i> (Burt Davy) Codd
nyokani	<i>Cryptolepis capensis</i> Schltr.	ximombonkanyi	<i>Lannea stuhlmannii</i> (Engl.) Engl.
N'		ximombyana/ximupyani	<i>Lannea stuhlmannii</i> (Engl.) Engl.
n'wamidumba	<i>Faurea saligna</i> Harv.	ximowu/ximuwu	<i>Lannea discolor</i> (Sond.) Engl.
n'wamidumba	<i>Faurea speciosa</i> (Welw.) Welw.	ximutswani	<i>Adansonia digitata</i> L.
P		xinkanyana	<i>Lannea discolor</i> (Sond.) Engl.
phalavurha	<i>Ficus capreaefolia</i> Del.	xinkuwana	<i>Lannea discolor</i> (Sond.) Engl.
pundze	<i>Setaria</i> sp.	xinungu	<i>Ficus capreaefolia</i> Del.
R		xinungumafi	<i>Ozoroa reticulata</i> (Bak. f.) R & A Fernandes subsp. <i>reticulata</i> var. <i>reticulata</i>
raboda	<i>Colocasia antiquorum</i> Schott	xinyokanyokane	<i>Ozoroa engleri</i> R. & A. Fernan- des
rhanga	<i>Cucurbita maxima</i> Duch.	xipalatsi	<i>Gnidia rubescens</i> B. Peterson
rhanga	<i>Cucumis melo</i> L.	xipokota	<i>Dalbergia melanoxylon</i> Guill. & Perr.
ricinda	<i>Gossypium herbaceum</i> L. var. <i>africanum</i> (Watt) J. B. Hutch & Ghose	xiputu	<i>Cussonia spicata</i> Thunb.
		xirhombe/xirhomberhombe	<i>Blumea gariepina</i> DC.
		xirhombe/xirhomberhombe	<i>Ficus burkei</i> (Miq.) Miq.
			<i>Ficus stuhlmannii</i> Warb.

xirhombehleta	<i>Zanthoxylum capense</i> (Thunb.) Harv.	xivopfu	<i>Themeda triandra</i> Forssk.
xirhomberhombe xantsava	<i>Ficus sonderi</i> Miq.	xivudzi	<i>Artabotrys brachypetalus</i> Benth.
xisidani	<i>Acacia davyi</i> N.E. Br.	xixwene/xixwenelamhofu	<i>Spilanthes mauritiana</i> (Pers.) DC.
xiisalala	<i>Gardenia spatulifolia</i> Stapf & Hutch.	xiyimanamurhi	<i>Maerua angolensis</i> DC.
xivambula	<i>Flacourtia indica</i> (Burm. f.) Merr.	xotse/xotso	<i>Cocculus hirsutus</i> (L.) Diels

A brief account of coast vegetation near Port Elizabeth

H. C. TAYLOR* and J. W. MORRIS**

ABSTRACT

The environment and vegetation of an area of coast north-east of Port Elizabeth, South Africa, are briefly described. Five major vegetation categories are recognized. These are: 1. *Scaevola thunbergii* Pioneer Vegetation of littoral dunes and *Ficinia lateralis* Sedgeland of calcrete gravel; 2. *Olea exasperata* Bush, *Pterocelastrus tricuspidatus* Bushclumps and Dune Woodland; 3. Sundays River Scrub; 4. Fynbos of calcrete areas; and 5. *Themeda triandra* Grassland. Invasion of the area by *Acacia cyclops* (Australian Wattle) is described. A recommendation for the conservation of the area as a nature reserve is made.

RÉSUMÉ

UN BREF COMPTE-RENDU DE LA VÉGÉTATION CÔTIÈRE PRES DE PORT ELIZABETH

Le milieu et la végétation d'une région côtière au nord-est de Port Elizabeth en Afrique du Sud, sont brièvement décrits. Cinq catégories principales de végétation sont reconnues. Elles sont: 1. La végétation *Scaevola thunbergii* pionnière des dunes du littoral et *Ficinia lateralis* Sedgeland de gravier calcaire; 2. *Olea exasperata* Bush, *Pterocelastrus tricuspidatus* Bushclumps et Dune Woodland; 3. Les buissons de la rivière Sundays; 4. Buissons de la région calcaireuse; et 5. Le *Themeda triandra* du Grassland. L'invasion de la région par l'*Acacia cyclops* (Wattle australien) est décrite. Une recommandation pour la conservation de la région comme réserve naturelle est faite.

INTRODUCTION

Some years ago the Botanical Research Institute was asked to report on the plant communities and rare and endangered species, if any, to be found within an area proposed for the development of an iron-ore loading berth on the coast opposite St Croix Island, approximately 25 km north-east of Port Elizabeth. An account of the results of the investigation, based on a number of visits to the area by the authors of this paper, was given by Taylor (1976). As no prior detailed ecological studies had been undertaken in the area, a relatively intensive study had to be made for reporting purposes. It is intended that this brief account will make the interesting information collected more readily available than in an unpublished Departmental report.

The area of the investigation, from the Coega River in the west to the Sundays River in the east, is bounded by the sea to the south-east and the national road from Port Elizabeth to Grahamstown to the north-west. The area extends about 18 km along the coast and about 4 km inland (Fig. 1).

Regional accounts by Schonland (1919) and Dyer (1937) have included brief descriptions of vegetation similar to that found in the study area. Olivier (1977) compiled a checklist from a nearby area while Penzhorn *et al.* (1974) described the vegetation of the Ado Elephant National Park which contains some of the same veld types although it is not on the coast. Edwards (1971) briefly described the terrestrial vegetation of the Swartkops Estuary area, a few km west of the study area.

PHYSICAL FEATURES

For approximately 300 m inland from the high water mark the area consists of relatively flat calcrete beds with occasional sand dunes. The ground then

risers, gently at first and later sharply, until it forms a low ridge which runs roughly parallel to the beach, approximately 1 km from the sea and 60 m above sea level. The seaward slope of the ridge consists of deep sand, partly exposed as open dunes and partly bush-covered. Inland of the ridge the land slopes gently downward toward the national road and is relatively flat with occasional depressions and high points. There are no permanent water bodies except for the two rivers bounding the area to the east and west.

Geologically, the area is underlain by shelly and chalky limestones, sandstones and conglomerates of the Alexandria Beds. These are exposed along parts of the ridge, inland of which the Beds are covered by a layer of sandy soil 10 to 40 cm deep.

The area is classified as semi-arid, with a temperate, oceanic climate. The average maximum temperature at Port Elizabeth, 25 km to the south-west, is 25.5°C, the average minimum is 7.1°C, the extreme

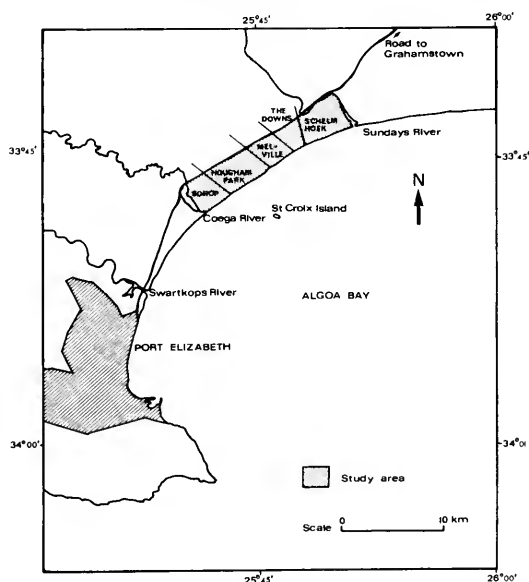


FIG. 1.—Location of the study area.

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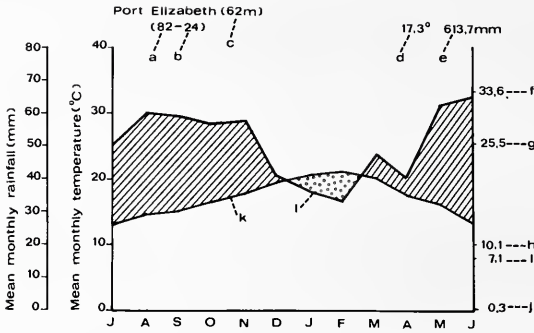


FIG. 2.—Climate diagram for Port Elizabeth. a, duration of rainfall record in years; b, duration of temperature record in years; c, altitude; d, mean annual precipitation; e, mean annual maximum temperature; f, mean daily maximum of hottest month; g, mean daily range of temperature; h, mean daily minimum of coldest month; i, absolute minimum; j, absolute maximum; k, trace of monthly means of temperature; and l, trace of monthly means of precipitation. Data from Anon. (1954) and Anon. (1965).

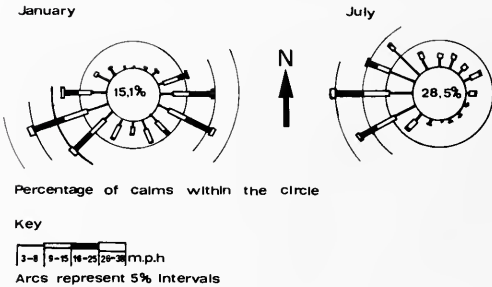




FIG. 4.—*Scaevola thunbergii* invading first dunes.



FIG. 5.—*Olea exasperata* is dominant woody sub-shrub in foreground; here less than 0,5 m tall.



FIG. 6.—*Pterocelastrus tricuspidatus* Bushclump with sea and St Croix island in background.



FIG. 7.—Dune woodland on bank of Sundays River. Dominants include *Brachylaena discolor*, *Sideroxylon inerme* and *Rhus crenata*.

Knysna region, with a few additional Natal elements, including *Brachylaena discolor* and *Sansevieria thyrsiflora*.

3. Sundays River Scrub

Although containing a few elements also found in the Forest Precursor Communities (e.g. *Sideroxylon inerme*, *Pterocelastrus tricuspidatus* and *Rhus crenata*), this Scrub is nevertheless physiognomically and floristically distinct and probably has a different origin and history. Acocks (1975), in his broad scale treatment, mapped the whole of the study area as Valley Bushveld, a specialized and complex group of vegetation units. In his Memoir, the description of Valley Bushveld Variation (d) (ii), Sundays River Scrub, fits this community very well. Practically all the trees, shrubs and climbers that he lists as of general occurrence in the Sundays River Scrub were found in at least one of the four samples studied, and many of the species of less general occurrence were also present. Acocks considered that the Sundays River Scrub Variation was derived directly from the Alexandria Forest, which he described as a decidedly xerophytic variation of coastal tropical forest. This explains the lack of close relationship with the Forest Precursor Communities, which appear to represent the beginnings of the more typical coastal subtropical-temperate forest in this region. Acocks also considered that the Sundays River Scrub was closely related to the Gouritz River Scrub of the valleys west of the Knysna forest region. A brief investigation of Gouritz River Scrub in the Klein Brak River Valley confirmed Acocks's surmise, but further comparative study is needed to clarify the relationships.

In the area studied, Sundays River Scrub is a bush formation occurring chiefly on light brown, shallow sandy soils in the Coega River Valley, spreading inland onto the flats near the national road. West of the Coega River it occurs extensively on similar flats as far as the Swartkops River. Where relatively undisturbed, it consists of a thicket of stout, often thorny shrubs, with a 2 to 3 m canopy and a total cover of 95 to 100%. In parts where browsing cattle have penetrated in numbers, as in the lower part of

the Coega Valley, the canopy has been reduced to 75 to 80% cover and to 1 to 2 m in height. On the borders of openings and along edges is a sparse, lower layer of soft-leaved herbs and where openings are extensive, smaller (20 to 30 cm), predominantly ericoid dwarf shrubs occur which, in a more detailed treatment, might be considered a separate community. There is also a high proportion of succulents, especially along the margins and in small openings. Many climbing species are present, often sprawling over the top of the canopy.

The community is floristically the richest encountered, with 50 to 60 species being recorded in 300 m² plots (Fig. 8). *Euclea undulata* was present in every relevé and was usually dominant. Other species with high frequency, and sometimes attaining dominance or sub-dominance, are *Rhus longispina*, *Cassine tetragona*, *Schotia afra*, *Sideroxylon inerme*, *Azima tetracantha* and a climber *Rhoicissus tridentata*. *Aloe ferox* is a prominent emergent, sometimes being up to 4 m tall. *Portulacaria afra*, though not in every relevé, appears to be associated with high successional development and high species diversity. *Panicum maximum* was found in every relevé and is a characteristic margin species.

4. Calcrete Fynbos

This is a dwarf shrubland formation occurring on very shallow soil (about 10 cm deep) over calcrete on the ridge, or its inland slopes (Fig. 9). Total cover is from 65 to 70%. An upper layer (barely 20 to 30 cm tall) of dwarf or sprawling shrubs (including ericoids) constitutes over 50% of the cover. A few emergents (40 to 50 cm tall) and a lower layer of creeping succulents and very short grasses, 10 cm tall, are present. Species numbers in relevés were between 25 and 35 and characteristically there is no single species dominant in the less disturbed stands, but the family Rutaceae is prominent and a *Restio* sp. (Taylor 9132) is occasionally present. No close affinities are known, but *Ficinia truncata*, a species found in all relevés, relates this community, at a high phytosociological level, to communities in similar habitats along the southern Cape coast, e.g. in the vicinity of Bredasdorp.

FIG. 8.—Open, short phase of Sundays River Scrub.



FIG. 9.—Calcrete Fynbos in foreground (note white pebbles). Sundays River Scrub visible in background where calcrete is replaced by deeper, brown, sandy soils.



FIG. 10.—*Themeda triandra* Grassland with isolated pocket of Sundays River Scrub on right. Note windspray 'pruning' of canopy.



5. Grassland

Themeda triandra Grassland is found on the flat plateau inland of Calcrete Fynbos, where the soil is not quite as shallow but is still underlain by calcrete (Fig. 10). Its upper layer is similar in height to that of Calcrete Fynbos (10 to 30 cm), but denser with over 50% of the 75 to 95% total cover being contributed by *Themeda triandra*, which is clearly dominant. *Ehrharta calycina* is sometimes subdominant. The ten other grass species found in the three samples studied do not contribute greatly to the cover, but indicate the mixed origin of this community. *Elionurus muticus*, *Eustachys paspaloides*, *Setaria sphacelata* and *Digitaria* sp. (Taylor 9091) are mainly distributed to the north and east, whereas *Cymbopogon marginatus* and *Plagiochloa uniola* are mainly concentrated to the south-west. Among the forbs, too, there is a mixture of tropical-derived genera, like *Barleria*, *Blepharis*, *Euphorbia* and *Tephrosia*, with genera typical of the fynbos of the south-western Cape, e.g. *Diosma*, *Ficinia*, *Stoebe* and *Passerina*. Due, perhaps to its mixed nature, this community had the second highest species numbers in relevés in the area, namely, 30 to 45.

On overgrazed sites, *Themeda triandra* assumes a minor role and dominance is taken over by *Aspalathus lactea* ssp. *adelphaea*, *Osteospermum imbricatum*, *Selago corymbosa*, *Psoralea fruticans* and *Euphorbia rhombifolia*, amongst others. On protected sites, by contrast, individual pioneer elements and isolated small thickets of Sundays River Scrub were noted which, from the nature of their margins, suggest that the Scrub may be spreading at the expense of the Grassland (Fig. 10). According to one local landowner, this is substantiated by accounts of early settlers who referred to the whole area as a grassy plain.

The balance between Grassland and Calcrete Fynbos also appears to be delicate, being influenced by depth of soil and by degree of grazing and trampling. Local farmers consider that fire is of minor importance as an ecological factor because the evenly-spread rainfall (Fig. 2) creates conditions that limit the occurrence and spread of wildfires, and the palatable grazing makes the use of intentional burning to produce new growth unnecessary.

EXOTIC PLANT INVADERS

About thirty-five years ago a landowner introduced the Australian Wattle, *Acacia cyclops* (also known as Rooikrans), to stabilize the driftsands on his property. This species now forms a thicket on the seaward escarpment and is actively invading the

Forest Initial Communities on the ridge and the Grassland and Fynbos beyond (Fig. 11). The Sundays River Scrub, due to the density of its canopy, is as yet largely free of Wattle, but where openings are being enlarged by cattle trampling, the Australian invader is gradually penetrating.

The farmer maintains that the infestation has not noticeably increased over the years, but judging from the abundant young growth of Wattle, especially along tracks, and its active suppression of the grass cover, colonization by this invader is proceeding apace. The tempo may, however, be less than in the Mediterranean-type climate of the south-western Cape where frequent dry-season fires encourage very dense regeneration from the heavy seed load in the soil.

Infestation in the Forest Precursor Communities, Grassland and Fynbos has now reached the critical stage where further spread of the invader will destroy the structure of the natural vegetation over one quarter to one third of the study area. If these plant communities are worth saving, both for their value as grazing and for their scientific interest and natural beauty, prompt action is necessary.

CONSERVATION

As far as is known, none of the communities described in this report are conserved at present, except for a few areas of Sundays River Scrub in the Tippers Creek Aloe Reserve at Swartkops, an area too small for viable ecosystem conservation. The Addo National Park consists of Addo Bush which, according to Acocks (1975), is a different variety of Valley Bushveld. The plant communities of the study area are of great variety, scientific interest and economic and recreational value. Some of them, such as Calcrete Fynbos, are not extensive elsewhere. It is our recommendation that the entire study area, bounded on three sides by natural features (Sundays River, Indian Ocean and Coega River) and on the fourth by a major road, should be conserved. A nature reserve of this size would be a worthy asset to the country as a sample of relatively well-maintained vegetation and a place for recreation and scientific study within 25 km of the fast-growing city and third largest port in South Africa, Port Elizabeth.

UITTREKSEL

Die omgewing en plantegroei van 'n gedeelte van die kus oos van Port Elizabeth, word kortliks beskryf. Die volgende vyf hoof-vegetasiekategorieë word ondersket: 1. Scaevola thunbergii-pioniervege-



FIG. 11.—Invasion of grassland by *Acacia cyclops* (Rooikrans).

tasie van strandduine en *Ficinia lateralis-biesieveld* van kalkgruis; 2. *Olea exasperata*-bos, *Pterocelastrus tricuspidatus*-bosklompe en duinewoud; 3. *Sondagsrivierstruikgewas*; 4. Fynbos van kalkgebiede; en 5. *Themeda triandra*-grasveld. *Indringing deur Acacia cyclops (Rooikrans) in die gebied word beskryf. 'n Voorstel vir die bewaring van die gebied as 'n natuureservaat word gemaak.*

REFERENCES

- ACOCKS, J. P. H., 1975. Veld types of South Africa. 2nd ed. *Mem. bot. Surv. S. Afr.* No. 40.
- ANON., 1954. *Climate of South Africa. Part 1. Climate statistics.* Pretoria: Weather Bureau.
- ANON., 1960. *Climate of South Africa. Part 6. Surface winds.* Pretoria: Weather Bureau.
- ANON., 1965. *Climate of South Africa. Part 9. Average monthly and annual rainfall and number of rain-days up to the end of 1960.* Pretoria: Weather Bureau.
- DYER, R. A., 1937. The vegetation of the Divisions of Albany and Bathurst. *Mem. bot. Surv. S. Afr.* No. 17.
- EDWARDS, K. Z., 1971. Vegetation. In Anon., *The Swartkops Estuary.* Port Elizabeth: The Swartkops Trust.
- OLIVIER, MARIA C. 1977. A systematic check list of the spermatophyta of the Baakens River valley, Port Elizabeth. *Jl S. Afr. Bot.* 43: 145-159.
- PENZHORN, B. L., ROBERTSE, P. J. & OLIVIER, MARIA C., 1974. The influence of the African elephant on the vegetation of the Addo Elephant National Park. *Koedoe* 17: 137-158.
- SCHONLAND, S., 1919. Phanerogamic flora of the Divisions of Uitenhage and Port Elizabeth. *Mem. bot. Surv. S. Afr.* No. 1.
- TAYLOR, H. C., 1976. *Report on the plant ecology of the St Croix coast.* Unpubl. Report, Pretoria: Department of Agricultural Technical Services.

Changes in the herb layer of the riverine woodland in the Sengwa Wildlife Research Area, Zimbabwe

P. R. GUY*

ABSTRACT

The changes in the dominant species of the herb layer, in particular *Blumea gariepina* DC., of riverine woodland in the Sengwa Wildlife Research Area in Zimbabwe, were monitored over a period of five years. Factors contributing to these changes appear to have been rainfall, utilization and interspecific competition.

RÉSUMÉ

CHANGEMENTS DANS LA COUCHE D'HERBE DU WOODLAND RIVERAIN DANS LA RÉGION DE RECHERCHE SUR LA VIE SAUVAGE DE SENGWA EN ZIMBABWE

Les changements dans les espèces dominantes de la couche d'herbe, en particulier *Blumea gariepina* DC., du woodland riverain dans la région de Recherche sur la Vie Sauvage de Sengwa en Zimbabwe ont été observés pendant une période de cinq ans. Les facteurs contribuant à ces changements apparaissent avoir été les chutes de pluie, l'utilisation et la compétition interspécifique.

INTRODUCTION

Following a period of below average rainfall, a perennial, unpalatable, woody herb *Blumea gariepina* DC., dominated an area heavily utilized by a variety of game species. The three year period of low rainfall together with the heavy game pressure may have caused the death of other species through over-utilization, allowing *B. gariepina*, an acknowledged pioneer of bare ground (Wild, 1969; Hilliard, 1977), to become established in the absence of competition (Goodman, 1975). As a result of its effect in decreasing the amount of palatable food in the herb layer, it was considered worthwhile to monitor the post invasion period of the riparian herbaceous layer by this unpalatable plant species.

STUDY AREA

The work was carried out in the Sengwa Wildlife Research Area (18° 10' S; 28° 14' E), an area of 373 km² lying at the southern end of the Chirisa Safari Area, Zimbabwe. The average rainfall for the area for the past thirteen years is 662 mm. The mean annual temperature is 22,2°C (Torrance, 1965). The vegetation is generally described as deciduous miombo savanna woodland on the sandy soils, and dry early deciduous savanna woodland, which is dominated by *Colophospermum mopane* on the heavier lower lying clay soils (Wild & Grandvaux-Barbosa, 1965). The major rivers of the area, the Lutope, Manyoni and Sengwa, have well-developed fringes of riparian woodland dominated by *Acacia alba*, *A. tortilis* subsp. *heteracantha*, *Kigelia pinnata*, *Lonchocarpus capassa*, and *Trichilia emetica*. The shrub layer is generally well developed being composed of, in particular *Combretum mossambicense*, *Diospyros senensis*, *Grewia flavescens* and *Securinega virosa* (Cumming, 1975). The establishment of *B. gariepina* occurred mainly in the riverine woodlands of the Sengwa and Lutope Rivers, areas heavily utilized by wildlife, but isolated groups of this species were found throughout the area in all vegetation types.

METHODS

Changes in the herb layer were recorded beginning in September 1974 using fifty quadrats each one metre square placed one metre apart along a randomly laid line in the central portion of the study area. The data collected from each species in the quadrats were density, maximum height to the nearest centimetre and above-ground biomass. The last-mentioned was measured by harvesting all the plants of each species at ground level within the quadrat. These plants were subsequently oven dried at 95°C for three days or longer immediately after harvesting. The recordings were made in September of each year along newly laid randomly placed lines.

The rate of colonization was studied by grading an open patch of about 1 000 m² free of all vegetation except for deeply rooted, small (<50 cm high), woody plants such as *Acacia tortilis* subsp. *heteracantha* and *Combretum mossambicense*. The grader blade was angled to remove the top 7,5 cm of soil to leave about 5,0 cm of the A horizon soil. In this way all seeds that may have been lying on the surface were also effectively removed. The frequency of the plants was determined in 40 permanently placed quadrats. The quadrat size used was 0,25 m². The quadrats were randomly placed within the graded area. These determinations were begun in January 1976 and continued each month for a year. The graded plot was allowed a 'settling down' period of three months before determinations were begun to allow the plants to grow to a size at which they could be identified with certainty. Determinations were discontinued after a year, because no differences between the frequency of plants within the plot and the same species outside of the plot could be detected.

In order to obtain an idea of the age to which *B. gariepina* will live, ten seedlings were tagged with aluminium labels in September 1974.

RESULTS

The results from the first part of the study in which the changes in density, frequency and biomass were measured, are presented in Table 1 and Fig. 1. The monthly frequencies for the most important species in the graded study area are shown in Fig. 2.

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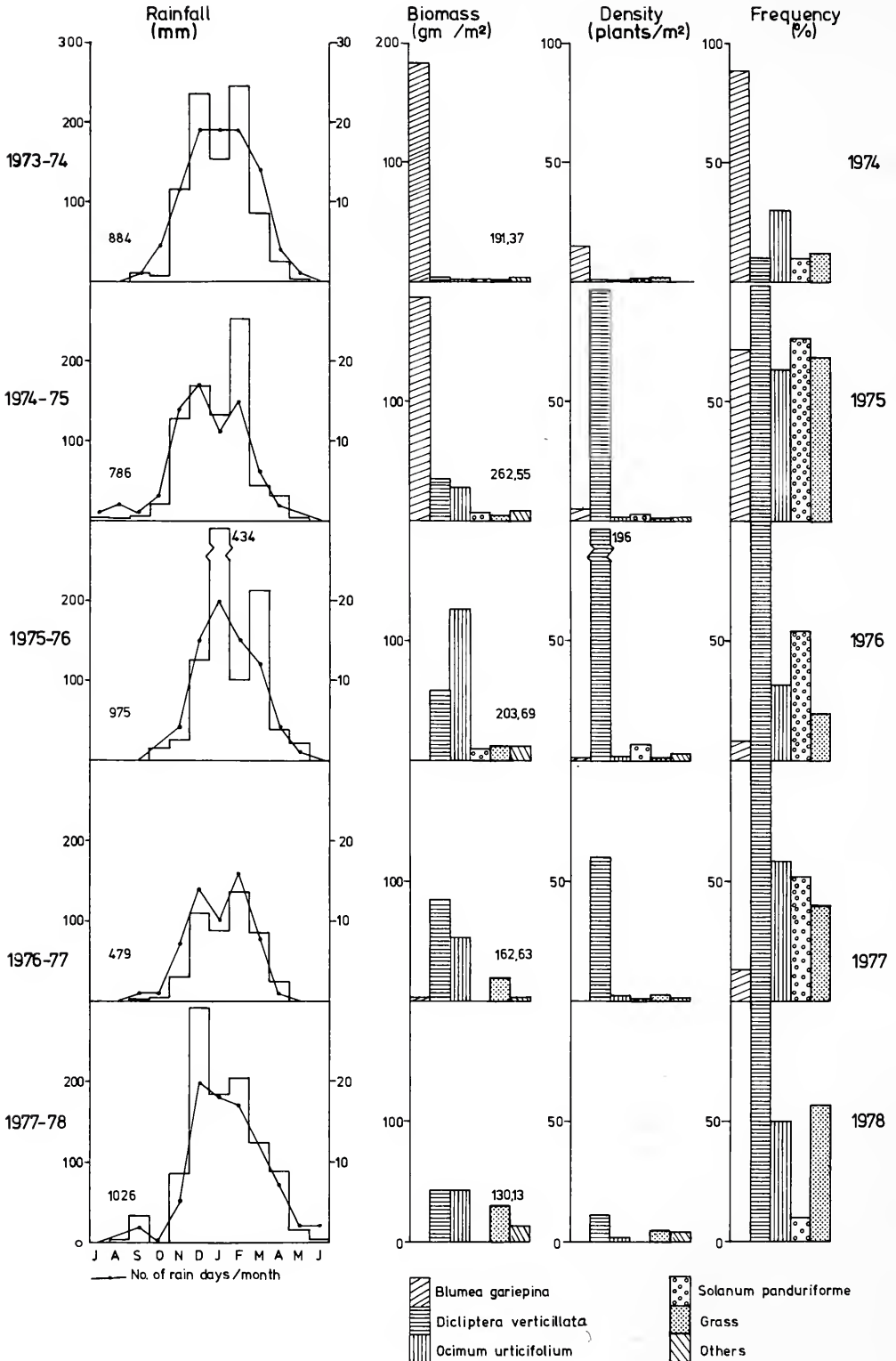


FIG. 1.—Changes in biomass, density and frequency of the most important species in the study area. The rainfall for the year preceding recording is given. The annual total rainfall and annual total biomass are indicated on each respective histogram.

TABLE 1.—The changes in average density, frequency, average maximum height and total above ground biomass of the most important species in the five years of recording

Year/Species	Average density (per m ²)					Frequency (%)					Average max. height (cm)					Total above ground biomass (gm/m ²)				
	'74	'75	'76	'77	'78	'74	'75	'76	'77	'78	'74	'75	'76	'77	'78	'74	'75	'76	'77	'78
<i>Aerva leucura</i>	0,05	0,6	0,6	0,34	0,12	2	24	8	16	12	10	12	32	14	2	0,06	1,18	0,8	0,07	0,03
<i>Achyranthes sicula</i>				0,28	0,02				2	2									0,02	0,08
<i>Blumea alata</i>			0,2		0,06			2						30	25				0,7	0,15
<i>B. gariepina</i>	15,0	4,9	0,4	0,14		88	72	8	14		68	67	12	12		183,0	187,0	0,4	3,09	
<i>Boerhavia diffusa</i>	0,2	0,02		0,04	0,06	6	2		2	4	5	3		4	4	0,6	tr		0,18	0,02
<i>Cocculus hirsutus</i>	0,1	0,2	tr	0,02	0,04	4	6	2	2	2	10	9	15	9	2	0,01	0,24	0,5	0,5	0,02
<i>Dicliptera verticillata</i>	0,5	96,0	196,0	60,0	10,5	10	98	100	100	100	42	24	27	31	29	3,2	34,9	52,4	84,1	42,96
<i>Indigofera praticola</i>				0,04					2					2					0,01	
<i>Leonotis nepetifolia</i>					0,02					2					56					0,93
<i>Leucas martinaceus</i>		0,1	0,16		1,10		8	4		34		22	20		42		0,15	0,02		11,26
<i>Ocimum urticifolium</i>	0,7	1,4	1,8	2,1	1,82	30	64	32	58	50	19	41	52	37	47	1,4	27,9	123,0	53,0	43,23
<i>Plumbago zeylanica</i>					0,02				2					5					0,08	
<i>Pterocaulon decurrens</i>			0,64					14					11					0,4		
<i>Rhinacanthus gracilis</i>		0,2					4					40					0,4			
<i>Sida alba</i>			0,24	0,58	0,24			6	16	12			18	14	10			0,06	0,08	0,55
<i>S. cordifolia</i>	0,5	0,5		0,58	0,10	22	26		24	6	18	10		15	17	1,4	0,13		2,1	0,02
<i>Solanum panduriforme</i>	0,8	2,8	6,9	0,48	0,26	10	60	54	18	10	9	17	23	17	11	0,4	6,4	9,7	0,5	0,11
<i>Vernonia cinerea</i>			0,4					6					15					0,01		
<i>V. poskeana</i>		0,1			0,10		8			6										
<i>Grass (various species)</i>	0,07	0,9	1,9	2,4	4,3	12	18	20	38	56	14	15	12	18	20		0,04			0,17

tr = trace (< 0,01)

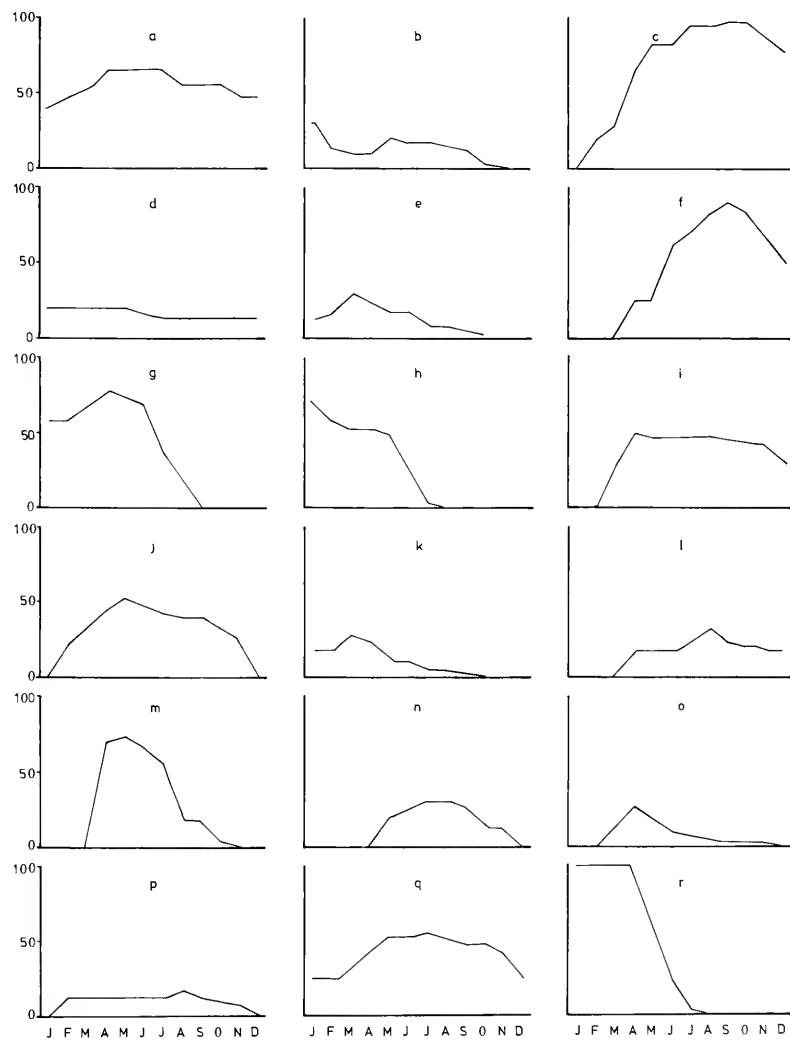


FIG. 2.—Changes in the frequency of *Acacia tortilis* subsp. *heteracantha* and herbs by month in the graded study area in 1976. a, *Acacia tortilis* subsp. *heteracantha*; b, *Amyranthus hybridus*; c, *Blumea gariepina*; d, *Boerhavia diffusa*; e, *Cassia* sp.; f, *Conyza aegyptiaca*; g, *Corchorus tridens*; h, *Dactyloctenium giganteum*; i, *Dicliptera verticillata*; j, *Eragrostis cilianensis*; k, *Indigofera* spp.; l, *Ocimum urticifolium*; m, *Oldenlandia herbacea*; n, *Pterocaulon decurrens*; o, *Sida alba*; p, *Sida cordifolia*; q, *Solanum panduriforme*; r, *Urochloa trichopus*.

In 1974, immediately following the establishment of *Blumea gariepina*, neither *Dicliptera verticillata* nor *Ocimum urticifolium* were well represented in the herb layer (Table 1, Fig. 1). *Blumea gariepina* was well established as the dominant species. In 1975, although there were large numbers of *Dicliptera verticillata*, *Blumea gariepina* was still the most important species, but by 1976 some three years after its establishment, *B. gariepina* had declined in dominance and only represented 0.2% of the total biomass (Table 1). At this time *Ocimum urticifolium* contributed the most to the total biomass and *Dicliptera verticillata* contributed the most to density. In the following year, *D. verticillata* was the dominant species in terms of both density and biomass. In 1977, the individuals of *D. verticillata* consisted of well formed plants in contrast to the numerous spindly seedlings of the previous year. This would account for its increase in biomass despite the considerable decrease in density (Table 1, Fig. 1). No single species was dominant in 1978, as both *Dicliptera verticillata* and *Ocimum urticifolium* had biomass figures of about 43 gm m⁻² (Table 1). The increasing importance of perennial grasses is of interest.

There appears to be a definite successional process taking place in the herb layer. All four important species show the same phenomenon. *Blumea gariepina* was observed on the downward part of the process, *Ocimum urticifolium* and *Dicliptera verticillata* through the full process with peaks in 1976 and 1977 respectively, and it appears that the perennial grasses are on the upward part of the succession. Of the 19 species (except grasses) recorded in the study area only five were present in all five years of study (Table 1).

The effectiveness of *Blumea gariepina* as a colonizer is clearly illustrated in Fig. 2. It rapidly increased in frequency and having reached a high frequency remained at that level. Other species reacted differently. The annual grasses *Urochloa trichopus* and *Dactyloctenium giganteum* decreased in frequency in May, at the end of the rainy season. Other species, *Boerhavia diffusa* and *Dicliptera verticillata* maintained their frequency albeit at a lower level, and some species, *Oldenlandia herbacea* and *Pterocaulon decurrens*, were present for only part of the year. Most species, however, had specific patterns of colonization, some were late colonizers particularly *Conyza aegyptiaca* and *Ocimum urticifolium*, and others *Corchorus tridens* and *Sida alba* increased in frequency only to decrease rapidly thereafter.

DISCUSSION AND CONCLUSIONS

Some of the success of *Blumea gariepina* as a pioneer can be attributed to its production of large amounts of wind dispersed seeds and its tolerance of wide soil and moisture conditions (Wild, 1969; Hilliard, 1977). In areas of high animal concentrations such as the study area, it success may be further attributed to its unpalatability. The leaf of *B. gariepina* on steam distillation yields a volatile oil which consists of 66% of cineol, 10% of d-fenchone and about 6% of citral (Watt & Breyer-Brandwijk, 1962). Cineol, the major constituent of oil of eucalyptus, is poisonous to man, and citral is the major constituent of lemon grass oil (Watt & Breyer-Brandwijk, 1962).

No animals have been observed to feed on *B. gariepina* despite its abundance. This may be related to the presence of cineol and citral making the plant unpleasant smelling. It may afford some protection to other species growing in its vicinity as Muller, Muller & Haines (1964) observed that dew caused deposition of volatile oils to take place on plants growing near aromatic shrubs. A sheen was observed on some herbs and grasses not normally glossy, growing at the base of *B. gariepina* plants. Perhaps the protection afforded to the grasses by these oils has encouraged their growth despite the continued heavy utilization of the area by game.

It is apparent that the initial fears that the area would become dominated by the unpalatable *B. gariepina* to the exclusion of the other species were unfounded. Seedlings of *B. gariepina* tagged in 1974 survived for three years, indicating that the normal life of the plant is probably not more than about four years. High densities of *B. gariepina* can be expected to be maintained for three or four years and possibly longer if conditions are ideal. The periods of higher rainfall may have caused the decline of *B. gariepina*, but this may have also been affected by the superior competitive abilities of the other species.

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UITTREKSEL

Die veranderinge in die oorheersende spesies van die kruidaag, veral van Blumea gariepina DC., in rivieroewerboomveld in die Sengwa Wildnavorsingsgebied, Zimbabwe, is waargeneem gedurende 'n periode wat oor vyf jaar gestrek het. Faktore wat bygedra het tot hierdie veranderinge is veral die reënval, verbruik en wedywing tussen die verskillende soorte plante.

REFERENCES

- CUMMING, D. H. M., 1975. *A field study of the ecology and behaviour of warthog*. Museum Memoir No. 7. Salisbury: The Trustees of the National Museums and Monuments of Rhodesia.
- GOODMAN, P. S., 1975. *The relation between vegetation structure and its use by wild herbivores in a riverine habitat*. M.Sc. thesis, University of Rhodesia (unpublished).
- HILLIARD, O. M., 1977. *Compositae of Natal*. Pietermaritzburg: University of Natal Press.
- MULLER, C. H., MULLER, W. H. & HAINES, B. C., 1964. Volatile growth inhibitors produced by aromatic shrubs. *Science* 143: 471-473.
- TORRANCE, J. D., 1965. The temperature of Rhodesia. In M. O. Collins, *Rhodesia: its natural resources and economic development*. 28-29. Salisbury: M. O. Collins.
- WATT, J. M. & BREYER-BRANDWIJK, MARIA, 1962. *Medicinal and poisonous plants of southern and eastern Africa*. 2nd edition, London: E. & S. Livingstone.
- WILD, H., 1969. The compositae of the Flora Zambesiaca Area, 2. *Kirkia* 7: 121-135.
- WILD, H. & GRANDVAUX-BARBOSA, L. A., 1967. Vegetation map of the Flora Zambesiaca Area. Supplement to *Flora Zambesiaca*. In H. Wild & A. Fernandes. *Flora Zambesiaca*. Salisbury: M. O. Collins & Government Printer.

Survival, regeneration and leaf biomass changes in woody plants following spring burns in *Burkea africana*—*Ochna pulchra* Savanna*

M. C. RUTHERFORD**

ABSTRACT

Effects of two intensities of spring burn on various aspects of woody plants of a *Burkea africana*—*Ochna pulchra* Savanna after one growth season are given. Mortality of woody plants was very low with, for example, that of individuals of *Ochna pulchra* being between 1 and 5%. Some species where the above-ground parts were often burned away completely, as in *Grewia flavescens*, no mortality of individuals occurred. Basal regeneration shoot mass was found to depend parabolically on plant height while the ratio of leaf to twig mass in basal shoot regeneration varied inversely with plant height in *Ochna pulchra*. The ability of *Ochna pulchra* plants to produce new basal shoots appeared to not only depend on size of the plant but also on the number of basal shoots present prior to the fire. In live *Ochna pulchra* plants basal regeneration shoot biomass per individual was found to increase exponentially with greater reduction in canopy leaf biomass. This relation was also affected by possible direct heat effects. Basal shoot regeneration mass was found to vary greatly with species and varied from 0.7 g/individual for *Dichapetalum cymosum* to 285.6 g/individual for *Euclea natalensis*. There was a clear tendency for non-suffrutescens shrub species to have greater mean basal regeneration shoot mass per plant than that of most tree species. There was a compensatory effect in *Ochna pulchra* between number and size of basal regeneration shoots. Standing dead woody plant individuals (before the burn) were either felled by fire or apparently unaffected by fire and there was no selectivity by species. Results of the present study are generally supported by other work on the effects of fire in savanna and some other vegetation types.

RÉSUMÉ

SURVIVANCE, RÉGÉNÉRATION ET CHANGEMENTS DE BIO-MASSA DE FEUILLE DANS LES PLANTES LIGNEUSES À LA SUITE DES BRULÂGES DE PRINTEMPS DANS LA SAVANNE BURKEA AFRICANA—OCHNA PULCHRA

Les effets de brulage de printemps de deux intensités sur les aspects variés de plantes ligneuses de savannes *Burkea africana*—*Ochna pulchra* après une saison de croissance, sont donnés. La mortalité des plantes ligneuses fut très faible avec, par exemple, celle des individus d'*Ochna pulchra* situant entre 1 et 5 %. Certaines espèces dont la partie au dessus du sol était souvent complètement brûlée, comme *Grewia flavescens* ne montrèrent aucune mortalité des individus. On trouva que la régénération de base des masses de rejets dépendait paraboliquement de la hauteur de la plante tandis que le rapport de feuille à la masse de brindille dans la régénération des rejets de base variait inversement à vec la hauteur de la plante chez l'*Ochna pulchra*. L'aptitude des plantes d'*Ochna pulchra* à produire de nouveaux rejets de base apparait non seulement dépendre sur la taille de la plante mais aussi sur le nombre de rejets de base antérieurement présents au brulage. Chez les plantes d'*Ochna pulchra* en vie, la bio-masse des rejets de régénération de base par individu fut trouvée s'accroître exponentiellement avec une réduction plus grande dans la bio-masse des feuilles du couvert. Cette relation fut aussi effectuée par des effets possibles de chaleur directe. La masse de régénération des rejets de base fut trouvée varier considérablement avec les espèces et elle varia de 0,7 g/individu pour le *Dichapetalum cymosum* à 285, 6 g/individu pour l'*Euclea natalensis*. Il y eut une claire tendance pour les espèces de buissons non-sous-arbrisseaux à avoir une plus grande moyenne de masse de rejets de régénération de base par plante que celle de la plupart des trois espèces. Il y eut un effet compensatoire dans l'*Ochna pulchra* entre le nombre et la taille des rejets de régénération de base. Les individus morts de plantes ligneuses debouts (avant le brulage) furent soit abattus par le feu ou apparemment pas atteints par le feu et il n'y avait pas de sélectivité par les espèces. Les résultats de la présente étude sont généralement soutenus par d'autres travaux sur les effets des feux de savanne et certaines autres catégories de végétation.

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1. INTRODUCTION

Fire has probably occurred regularly in the savannas of southern Africa, initiated first by agencies such as lightning and later increasingly by man. The structure of savanna is probably related to this incidence of fire. In the past fire, once started, could spread over vast areas of savanna but more recently fire is often contained by artificial fire breaks such as roads. Fire is used as a veld management tool for both livestock farming and wildlife conservation. The two main objectives of burning savanna for livestock farming are to remove moribund grass and to decrease the woody plant element. In wildlife management these two objectives are also important, but additional reasons include encouraging some form of rotational grazing, reducing the wild-fire hazard and controlling animal diseases and parasites (Trollope *et al.*, in press). In the savannas of the central-northern areas of the Transvaal the current frequency of fire is extremely variable from annually to only every few decades in more protected areas although the more common frequency may be described as between one and five years. Fires in savannas are usually surface fires, and crown fires are very rare although localized burning of canopies can occur. Controlled fires are almost always applied in or near the dry season, usually between May and November in southern African savanna vegetation areas. In these areas it is generally recognized that a fire earlier in this period is less effective in controlling tree growth than a fire later in this period (West, 1965). Effectiveness of late burns as a means of woody plant control is usually ascribed to the fire being hotter and the trees being more susceptible to heat injury at a time when growth has just started. However, Deeming *et al.*, (1972) point out that this stage of plant development (the rapid growth stage) indicates a 'high moisture content throughout the plant' which (as in other living fuels) acts as a heat sink since it takes considerable amounts of energy to dessicate this material. Only after dessication can such material itself act as a heat source. In contrast to burning in the dry season, it has been found (Anon, 1960) in the Transvaal lowveld that very little damage is done to trees and shrubs during late summer (February) veld burning when grass is green.

That fire can fundamentally affect many components of an ecosystem has long been recognized. Interest has been shown in many diverse effects, for example, the cycling of nutrients (Trapnell *et al.*, 1976; Christensen, 1977), changes in the water balance and the possible effects on past carbon dioxide changes in the atmosphere (Reiners & Wright, 1976), while work on woody plants has included classifying savanna woody plant species according to different degrees of fire tolerance with the study of the evolution of pyrophytic habits (Jackson, 1974), derivation of allometric fuel load prediction formulae (Kaul and Jain, 1967), modelling fuel mass (McNab *et al.*, 1978) and determining fire scar tree ring chronologies (Zackrisson, 1977).

The Scientific Committee on Problems of the Environment (set up by the International Council of Scientific Unions) informally co-ordinates as part of its mid term project 2 a short term (1977–80) international programme for the review of the ecological effects of fire. South African participation in this programme is co-ordinated by the Working Group for Fire Ecology of the Committee for Terrestrial Ecosystems initiated by the National Programme for Environmental Sciences of the Council for Scientific

and Industrial Research. The present paper forms part of the contribution by the South African Savanna Ecosystem Project on the ecological effects of fire (Anon, 1978). Results of an experimental burn within the South African Savanna Ecosystem Project are being prepared for publication as a synthesis report by M. V. Gandar (in press) where an overview is given of effects of fire on the abiotic, decomposer, primary producer and consumer components of the ecosystem. The present paper is limited to the more detailed effects of fire on the woody plant component.

The South African Savanna Ecosystem Project is being conducted on a portion of the recently-established Nylsvley Nature Reserve (3 120 ha in extent), 10 km south of Naboomspruit in the northern Transvaal. The basic ecological characteristics of the study area are described in Huntley and Morris (1978) while the project's overall objectives and research programme are outlined in Huntley (1978).

The study area lies on the edge of the Springbok flats on a slightly raised plateau at about 1 100 m above sea level. Most of the Waterberg System sandstone bedrock is covered by sandy soils belonging mainly to the Hutton and Clovelly forms (Harmse, 1977). Mean annual rainfall is about 630 mm and occurs mainly in summer. The mean annual air temperature is 18.6°C. The study site's past management has included light summer grazing by cattle with small populations of impala and fluctuating populations of kudu present. The main vegetation type of the study area has been classified as *Eragrostis pallens*—*Burkea africana* Tree Savanna (Coetzee *et al.*, 1976) with the most extensive variation of this being the *Eragrostis pallens*—*Dombeya rotundifolia* variation with dominant trees *Burkea africana* and *Terminalia sericea* and dominant shrubs *Ochna pulchra* and *Grewia flavescens*. Huntley (1977) has suggested that the broad-leaf savanna of the study site is related to the mesic and moist broad-leaf savanna biome of Africa. In the year before the experimental burning, there had been no grazing by cattle in the area to be burned. Since the area had been unburned for some years and had a recent history of very low grazing pressure the graminoid fuel load was probably above average for the given type of vegetation although the nutrient-poor sandy soils may be expected to result in a generally lower heat intensity and slower fire than in several other vegetation types (Anon, 1960). The presence of trees also tends to result in a reduction in graminoid fuel load beneath them so that intensity and frequency of burning may be expected to be reduced by the trees (West, 1965). Given the tree leaf litter input each year (from June to August) and the relatively low decomposition rates (especially for leaves of *Ochna pulchra*), thick layers, sometimes up to 10 cm deep, occurred below certain trees. On the whole, the ground fuel composition of the experimental site was mixed with graminoid, tree leaf litter and some wood pieces of varying dimensions.

The main objectives of the present study were to determine the short term effects of two intensities of spring burn on the individuals of each woody plant species population in a selected area of the Nylsvley study site, with particular attention being given to mortality/survival, degree of canopy reduction, degree of basal regeneration, changes in leaf biomass and to relationships between these aspects.

2. SELECTIVE LITERATURE REVIEW

Work on the effects of fire on individual woody plants in African savanna appears to have been mainly concentrated on mortality or survival of plants after fire. Less attention has been given to effects of fire on plant canopies and the stimulation of basal shoots. Very little work has apparently been done on establishing and quantifying the interrelationships between different plant dimensions and mass components after fire (pyro-allometry). Such relations may be used to predict, for example, the degree of dependency of leaf mass re-distribution within the plant on the size of the plant following fire. The limited effort in this last mentioned respect possibly relates to the difficulties involved in determining the fire effects on the different organs of the woody plant individual and to the variable degree to which ground fires reach into the canopy stratum of woody vegetation as well as to the often very heterogeneous spatial distribution of woody plants in savannas. Published work on the particular fire effects and plant species considered in the present study has included various, sometimes conflicting, findings.

a) *Mortality/survival of plants after fire*

Relatively low mortality of some woody savanna plants with fire has been indicated by, for example, the classification in Malawi of *Burkea africana* as a 'pyrophytic' species (Jackson, 1974). In the Kavango region of South West Africa, Geldenhuys (1977) tested for mortality in *B. africana* with fire in an analysis of co-variance and despite the high proportion of dead trees (35.3% at Rundu), this was not attributable to treatment. Of the four most common woody plant species in a Nigerian savanna after annual (late winter) burns for five years, only *B. africana* had all individuals (from 4 to 13 m height) survive. *B. africana* increased relative to the other species with fire and it is suggested that it is through better adaptation to fires that certain *B. africana* savannas may have arisen (Hopkins, 1965). In contrast to the above findings, van Rensburg (1971) reported that some *B. africana* trees 'were damaged and killed' in *Terminalia sericea* Woodland on sand in eastern Botswana after an April burn (toward the end of the normal rainy season). However, mortality of *Burkea africana* trees has been reported to be not necessarily linked to the effects of the fire in several areas (Rutherford, in press). Tinley (1966) only refers to coppices of *B. africana* being 'very sensitive to fire' in the northern Okavango Swamps of Botswana.

Effects of long-term application of fire may differ from the expected short-term effects. Thus, for example, in *Terminalia sericea*—*Burkea africana* Savanna at Matopos, Zimbabwe, Kennan (1971) reports fewer trees present in long-term fire treated plots than in fire protected plots. There was also a much smaller proportion of those trees below 0.9 m in height in the fire treatments than in the protected plots. In *Burkea africana*—*Terminalia avicennoides*—*Detarium microcarpum* Savanna Woodland in Nigeria, Afolayan (1978) found that annual 'late' (presumably late in the dry season) burning for four years decreased tree density particularly for trees less than 10 cm girth at breast height.

The effect of fire on seedlings has been observed in Matopos savanna, Zimbabwe, where burning at three year intervals resulted in many tree seedlings being killed (West, 1965).

Other woody plant species in the present study have been characterized on other sites in terms of

their ability to withstand fire. In the Transvaal lowveld, Van Wyk (1971) reported that *Terminalia sericea* and *Dichrostachys cinerea* were to a 'certain extent fire resistant' and despite burning to ground level sprouted vigorously after the burn. In Zambia, Trapnell (1959) found that 'the fire-tolerance of *Dombeya rotundifolia* has been confirmed by repeated field observation', and that *Strychnos pungens* was semi-tolerant with *Lannea discolor* probably also so. Lawton (1978) includes *Ochna pulchra*, *Strychnos pungens* and *Burkea africana* in a group that can survive intense dry season fires in parts of north-eastern Zambia. In Wankie National Park, Zimbabwe, Rushworth (1978) found that *Terminalia sericea* and *Ochna pulchra* were 'strikingly frost hardy' and points out the similar coppicing reaction of some other species due to both frost and fire. Geldenhuys (1977), in two regularly burnt areas of the Kavango region of South West Africa/Namibia, refers to *Ochna pulchra* as a 'fire-sensitive' species. However, it appears that this finding might be limited to trees with measurable diameter at breast height.

Many other woody plant species in African savanna also appear to be relatively tolerant of fire. Thus in *Acacia thornveld* (*A. karroo*) at Matopos, complete killing of woody plants by fire of various fire regimes was extremely rare and nearly all affected plants regrew vigorously from their undamaged bases after the fire (Kennan, 1971). In eastern Cape *Acacia karroo* vegetation, Trollope (1974) found in a spring head fire that mortality of *A. karroo* was 9.9% of which more than three-quarters of the plants were between 1 and 2½ m tall. In the Molopo area of the northern Cape, Donaldson (1966) reported that even with dry grass artificially packed around the base of *Acacia mellifera* subsp. *deinensis* plants, the grass burns (at various times of the year) only resulted in a mortality of about 15%. Only when large amounts of wood and twigs were burned at the bases did a 75% mortality obtain here due to much longer duration of heat. In other African savannas, *Pterocarpus angolensis* has been classed as 'fire-tolerant' (Zambia: Trapnell, 1959) and in east Africa *Balanites aegyptica* Savanna no evidence was found of the death of mature trees being affected by a mainly annual fire regime (Harrington & Ross, 1974). Although Trapnell (1959) reported the dominant canopy species of *Brachystegia*, *Julbernardia* and *Isobertinia* (in Zambia) to be 'fire tender' (but not 'fire intolerant'), West (1971) states that some of these are 'extremely fire tolerant' but states that even these will eventually be eliminated by sufficiently regular, intense, late dry season burns every year. At Matopos, Kennan (1971) found 'that burning had much the same effect on the sandveld trees as in the thornveld ...' so that mortality in the sandveld woody plants was presumably also very low. The relatively high fire tolerance of woody plants of the present study and other savanna woody plant species is not limited to Africa. For example, in a Texan *Pinus taeda*—*P. echinata* forest with a head fire, it was found (Stransky & Halls, 1979) that of the 10 most important understorey woody plant species, three (for example, *Cornus florida*) had zero mortality and all others except one had less than 32% mortality.

A possible effective adaptation to fire in savannas is the suffrutescent or 'underground tree' form such as that of *Dichapetalum cymosum* that West (1971) has suggested as a possible evolutionary adaptation that resulted in evading fire. The reaction of trees to fire

and the possible fire adaptations have resulted in many savannas being regarded as seriously limiting the effectiveness of fire alone as a woody plant controlling mechanism for management purposes, for example, in eastern Cape *Acacia karroo* Savanna (Du Toit, 1972a) and *Brachystegia spiciformis*—*Julbernardia globiflora* Savanna of the Zimbabwe highveld (Barnes, 1965). In the latter area, burning intervals longer than annually have been found to be ineffective in preventing coppice becoming increasingly vigorous (Barnes, 1965). However, Van Wyk (1971) stated that in *Dichrostachys cinerea*—*Terminalia sericea* Savanna in the Transvaal lowveld, burning as little as every three years resulted in plants seldom escaping the regular damage to reach maturity. It appears that fire as a tool for the management and control of undesirable woody plants differs in its effectiveness according to area and conditions of application.

b) Effects of fire on plant canopies

Fire often greatly affects the canopy of woody savanna plants, particularly those of smaller plants. After a hot November burn in *Burkea africana* Savanna in South West Africa, canopy (but not plant) mortality of the plants less than 2 m tall was greater than 75% for each of the 4 most common woody species (*Burkea africana*, *Terminalia sericea*, *Combretum psidioides* and *Ochna pulchra*) with most (90%) for *Ochna pulchra* (Rutherford, 1975). In the Transvaal lowveld Van Wyk (1971) reported that *Terminalia sericea* (and *Dichrostachys cinerea*) plants of up to about 1.2 m were generally burnt back to ground level although some *Terminalia sericea* trees up to 3.7 m height had also been burned back. In eastern Cape *Acacia karroo*, 95% of canopy mortality after fire was limited to plants under 2.5 m tall (Trollope, 1974). In *Burkea africana* Savanna (regularly burned at the end of the dry season) at Makambu, Kavango in South West Africa, Geldenhuys (1977) found that for shrubs and trees (with stems less than 5 cm DBH) canopy volume dropped by two-thirds relative to that of the control. Mean height of this plant group was 0.9 m compared to 2.2 m of those of the control, that is a decrease of about 60%. That fire generally reduces the canopy heights of lower woody vegetation in many other regions is supported by studies such as that in a Texan forest fire (Stransky & Halls, 1979) where for the ten most important understorey woody species height decreased by 41% from 4.4 m to 2.6 m.

After a hot November burn in a *Burkea africana* Savanna in South West Africa, canopy mortality of *Securidaca longipedunculata* plants greater than 2 m tall was the lowest of six species, namely zero per cent (Rutherford, 1975).

In *Acacia* veld at Matopos, Kennan (1971) states that in the case of larger trees, burning invariably caused complete defoliation ('if they were in leaf when burning took place') but seldom did more than to kill branches up to a height of about 1.8 m. However, in the eastern Cape, it was found that canopy mortality of surviving individuals of *Acacia karroo* was 79% (Trollope, 1974). Donaldson (1966) found with burning *Acacia mellifera* subsp. *detinens* in the northern Cape with fuel (grass, wood, dung or sawdust) at the base of the plants, that generally there were total 'top-growth kills'.

Although it is clear from the evidence that fire may be expected to reduce canopy leaf biomass, it appears that the effect on radial stem growth may be different

since in the Kavango region of South West Africa it was found that there was no significant effect of annual fire treatments on stem basal area increment over a nine year period in *Burkea africana* and other species investigated (Geldenhuys, 1977) while also in Nigerian savanna it was found that controlled burning early in the dry season would permit an increase in established trees' basal area (Kemp, 1963).

c) Fire and basal shoots

In many studies it has been found that the number of stems are likely to increase with fire. For example, in a Texan forest fire mean stem number of the ten most important understorey woody plant species increased from 1.5 to 2.1 with a maximum increase for one species (*Ilex vomitoria*) from 2.2 to 5.1 (Stransky & Halls, 1979). A common phenomenon under total fire protection in savanna, is for woody thickets to tend to develop. However, Harrington (1974) points out that in Uganda despite the densest appearance of *Acacia hockii* in an unburnt treatment (relative to that in several burning regimes) it had the lowest number of stems per bush (and the lowest number of bushes per hectare).

After a hot November fire in a *Burkea africana* savanna in South West Africa, it was found that of the three species *Terminalia sericea*, *Burkea africana* and *Ochna pulchra*, the first mentioned had the greatest percentage of plants with basal regeneration shoots present (Rutherford, 1975). In scrub sand veld savanna in Wankie National Park, Zimbabwe, Rushworth (1975) found that whereas the mean number of new coppice stems produced on *Terminalia sericea* in an area unburned for at least eight years was zero, those burned in just under three months prior to measurement (an early October burn) was 20.33 (versus 0.05 in an area with approximately the same burning history as above but without the October burn). Van Wyk (1971) has reported vigorous sprouting of *Terminalia sericea* after a burn in the Transvaal lowveld. Donaldson (1966) has also commented that the multistemmed *T. sericea* of the Molopo area of the northern Cape have possibly resulted from periodic grassfires in the past.

Interrelationships after fire

After a hot November burn in *Burkea africana* Savanna in South West Africa, data showed that a higher percentage of plants with canopies killed had basal regeneration shoots present than those with canopies that survived for all species investigated (Rutherford, 1975). These included *Burkea africana*, *Terminalia sericea* and *Ochna pulchra*. In eastern Cape savanna, Trollope (1974) showed that after a spring head fire, of those *Acacia karroo* trees that survived and had formed basal regeneration shoots after the fire, 86% had canopies killed leaving only 14% with live canopies. James & Smith (1977) state that 'extensive suckering does not usually occur after low-intensity fires' while Farmer's (1962) work on *Populus tremuloides* demonstrated that suckering was related to the reduction of apical dominance by damage to the above ground parts.

3. METHOD

a) The two burns

Three one hectare square blocks of Camp 2 of the Nylsvley study area were burned separately before the remainder of the camp on September 5, 1978. All work on the woody plant species was done in two of

these hectare blocks which were about 1 km apart. Both areas were ignited at one side of the hectare block with flame-throwers directed at the herbaceous layer which allowed the fires to rapidly attain their maximum intensities. Plot 1 was ignited at 19h01 and plot 2 at 18h00. The mean windspeed at 2.0 m above ground from 12h00 on September 5, 1978 to 07h00 September 6, 1978 was 1.8 ms^{-1} (Harrison, 1978). Both fires were ignited as head fires (burning in the same direction as the wind) although in plot 1 there was some degree of backburning (burning in the opposite direction to the wind) of some islands left unburned after the main flame front had past. At 19h00 (corresponding to time of burn in plot 1) screen climatic data gave: air temperature 17.2°C ; relative humidity 33%; vapour pressure 6.4 mb and saturation vapour pressure deficit 13.1 mb. At 18h00 (corresponding to time of burn in plot 2) screen climatic data gave: air temperature 19.0°C ; relative humidity 28%; vapour pressure 8.5 mb and saturation vapour pressure deficit 13.3 mb (Harrison, 1978). Mean moisture content of plants (mainly grasses) of the herbaceous layer one week prior to the fires was 4.2% (Grunow and Grossman, 1978). Estimated ground fuel loads (see Section 3c) showed more frequent higher levels in plot 2 than in plot 1. Fuel loads were sometimes very localized, for example, typical individuals of the shrub species *Grewia flavescens* (type 1, less than 2.5 m height, — Rutherford, 1979) had $4\,800 \text{ gm}^{-2}$ of thin finely divided standing dead wood on the area they covered. Other areas were sometimes virtually bare, that is, less than 10 g of dry herbaceous material for individual square metres. Data on mean herbaceous layer dry mass per unit ground area are not available for the two plots but from many other clipping studies (Huntley & Morris, 1978) on the study site, the mean mass of the standing dead grass lay between 50 and 125 gm^{-2} . Ladder fuel in larger trees was rare, that is, there was usually no continuous fuel path from the herbaceous layer to the tree canopy.

Differences in the behaviour of the burns are given in Table 1. The burn in plot 2 was more than five times faster, fire temperatures were higher, flame heights were greater and burning on an area basis more complete than in plot 1. Although on the basis of these data the fire in plot 2 might be regarded as more intense than in plot 1, because of difficulties in averaging the great differences in heat intensity at different levels above ground, the fire in plot 1 is referred to as the slower burn and that in plot 2 as the

faster burn. This designation may be appropriate since speed of fire (whether 'self' generated or wind induced) appears to be important to fire behaviour. That head fires are faster than back fires is commonly observable. Trollope (1978) found greater flame lengths in head fires and a positive correlation between rate of spread and flame height and maximum temperatures at grass canopy height in head fires. In laboratory simulated experiments, Gill (1974) indicated an increasing flame height with increasing wind speed (up to 0.48 ms^{-1}). Wind affects fire behaviour by increasing the flow of oxygen to the fire and (in a head fire) wind bends the flames over the unburned fuel and increases the flow of hot gases from the combustion zone; both processes contributing to the pre-heating of the unburned fuels (Deeming *et al.*, 1972) which is particularly important for realizing the potential of water-conducting woody material as fuel.

b) Experimental layout

The two plots selected, contained woody and herbaceous elements that were floristically and structurally typical of the Nylsvley study area vegetation. Since the method of recording certain aspects of the plant was different for tree individuals and multi-stemmed shrubs (see next section) data were processed separately for these two groups but so as to prevent the same species from occurring in both groups, the groups were defined as the tree species group, that is, individuals that were trees or normally have the potential to grow into tree-sized individuals; and the multistemmed shrub species group whose members seldom form tree-sized individuals on the Nylsvley site. In the slower burn area, tree species were (in order of abundance): *Ochna pulchra*, *Burkea africana*, *Terminalia sericea*, *Strychnos pungens*, *Securidaca longipedunculata*, *Dombeya rotundifolia* and *Dichrostachys cinerea*. The multistemmed shrub and suffrutex species were: *Grewia flavescens*, *Fadogia monticola*, *Lannea discolor*, *Euclea natalensis* and *Vitex pooara*. In the faster burn area tree species were (in order of abundance): *Ochna pulchra*, *Burkea africana*, *Terminalia sericea*, *Vitex rehmannii*, *Dombeya rotundifolia*, *Strychnos pungens*, *Securidaca longipedunculata*, *Combretum molle*, *Strychnos cocculoides*, *Acacia caffra*, *Ximenia caffra*, *Sclerocarya caffra* and *Papaya capensis*. Multistemmed shrub and suffrutex species were: *Grewia flavescens*, *Dichapetalum cymosum*, *Euclea natalensis*, *Fadogia monticola* and

TABLE 1.—Differences in fire behaviour characteristics between two plots

	Time for main flame front to pass over one hectare square block * (minutes)	Mean tempil plate temperature ($^{\circ}\text{C}$) +	Incidence of aluminium plate ** melting (at 20 cm above ground), i.e. $>660^{\circ}\text{C}$ (%)	Estimated flame height * — mean — max — (m) (m)		Estimated ground level fuel load ***	% of tagged woody plants remaining on unburned islands
PLOT 1	11	<260	0.52% (n=407)	1–2	5	low	37
PLOT 2	2	±350	1.46% (n=412)	2–3	8	medium	3

* B.J. Huntley (pers. comm.)

+ Harrison (1978)

** Plates described section 3b

*** Estimates described section 3c

Asparagus suaveolens. Typical structural features of the vegetation can be seen in the photographs (Figs. 1–6). At the time of the fire many of the woody plants, particularly those of *Ochna pulchra*, were starting to unfurl new leaves. The most advanced leaves on some individuals of *O. pulchra* were about 2 weeks old. All the more common species (except *Strychnos pungens*) had dropped their old leaves before the fire so that almost all of the woody plant leaves formed in the previous growing season were already added to the fuel load on the ground prior to the fire. Also present at the time of the fire were a few woody plant seedlings, mainly those of *Burkea africana*. The dominant grass in both burn plots was *Eragrostis pallens*.

In each plot a subplot of 30 × 50 m was placed centrally and demarcated. In the subplots all sizes of standing individuals of woody plant species were tagged with numbered aluminium plates (either on 20 cm high stakes at the base of smaller individuals (Fig. 1) or on to the trunk of large individuals) in one half of the area. All individuals equal to or larger than 2 m height were tagged in the other half to increase the

area. The individuals of this new control set were geographically close to the burn treatments, probably had a very similar treatment history in the past and were also measured in exactly the same way and time as the burned individuals. It transpired that the effects of fire were so profound that differences between treatment and control were usually so great that statistical analyses of most differences, especially those concerning basal regeneration, were superfluous. The control in many respects only served to confirm the obvious. References to unburned control data are thus kept to a minimum with more attention being given to the differences between the two burns.

c) Measurements

Recordings of plants were made, (i) shortly before the burns, (ii) just after the burns, (iii) at monthly intervals after the burns and (iv) after completion of one season's growth but before commencement of leaf fall. Most detailed measurements were made in periods (i) and (iv).

One to two weeks before the burns, each woody



FIG. 1.—A view on the 6th September after the fire of part of one of the burned areas revealing aluminium tags marking small woody plants normally largely concealed in the herbaceous layer.

sample size of the larger individuals. All standing dead individuals equal to or larger than 2 m height in the remainder of each one hectare plot were also tagged and numbered. In the slower burn plot there were altogether 607 tagged individuals in the subplot and two additional dead individuals in the rest of the hectare plot. In the faster burn plot 425 individuals were tagged in the subplot and an additional 12 dead individuals in the remainder of the plot. Altogether 1 046 individuals were thus tagged for recording the effects of fire. The day following the burns it was found that in the slower burn area 37% and in the faster burn area 3% of tagged individuals had escaped the fire altogether on large unburned islands with each of these individuals having no vegetation burned on their canopy ground projection area. Since such a relatively high proportion of individuals was altogether untouched by fire, it was decided to use these unburned individuals (from both plots) as a control rather than the originally envisaged tagged individuals already being monitored as part of a separate programme in Camp 3 of the Nylsvley study

plant individual was allocated a numbered aluminium tag, and the tag position was also recorded for relocating the plant later. The species and live or dead state of the plant was recorded. Also measured were height of plant above ground level, number of live basal shoots (these constituted the whole individual in small non-canopied individuals) and number of dead basal shoots. Estimates were made of the proportion of canopy volume that was dead using a five point scale (0–9.9; 10–34.9; 35–64.9; 65–89.9; 90–100%) based on zones of dead twigs. Also estimated was the relative amount and composition of ground layer fuel load under the individual on a three point scale and with 3 type classes, namely, woody plant leaf litter, dead standing grass and pieces of wood material (e.g. Fig. 2). This ground layer fuel classification only applied well to individuals up to about 2½ m height. The area under large individuals was relatively large with often great differences in ground fuel load under the same tree. Photographs of various parts of the vegetation were taken from reference positions.

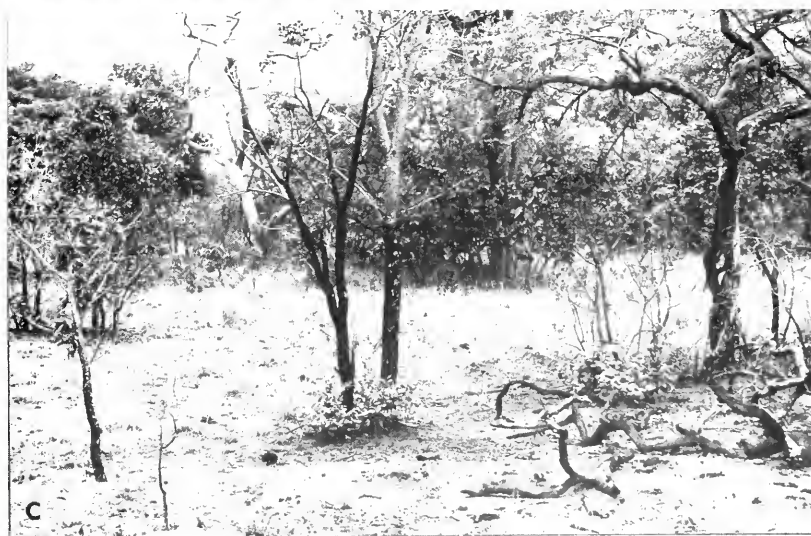
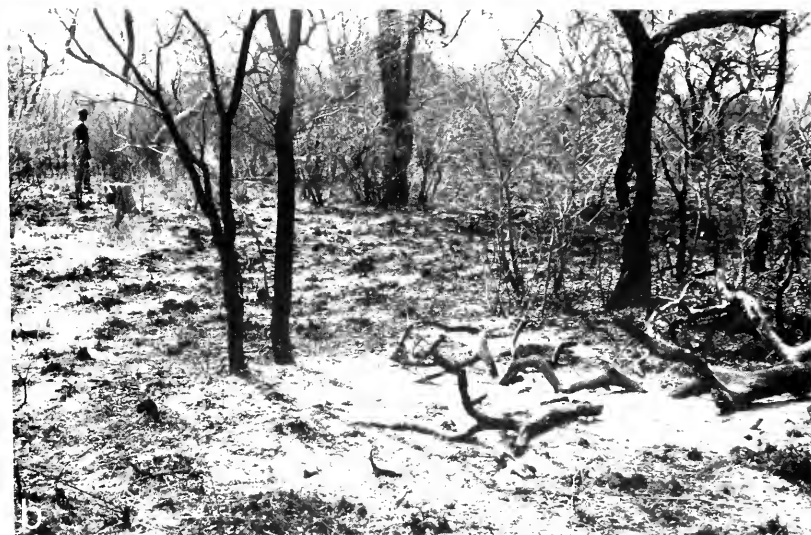


FIG. 2.—A pair of *Burkea africana* stems to the left of centre; a stem of a *Securidaca longipedunculata* tree on the right; *Ochna pulchra* individuals immediately behind and to both sides of the *Securidaca* stem and dead fallen branches of *Burkea africana* in the right foreground, showing: a, on the 5th September before the burn the relatively high fuel load; b, on 6th September after the burn, the ash production from burned, fallen branches also showing the incomplete burn of other branches; c, on 6th February at the end of the growth season and the basal regeneration from the *Burkea* stems and the appearance of the new grass cover.

One and two days after the burns, all labels were checked for legibility and position and a few replaced where necessary. Whether the plant was burned or totally untouched by fire was recorded as was an estimate of degree of burn namely: burned, for a broad class including plants that fire had touched at least at some point of where ground fire occurred under at least part of the canopy; severely burned for plants where most leaves or other parts of the plant were at least severely scorched; and completely burned where the plant's aboveground parts were completely burned away or at most only a very short stub (1 or 2 cm high) remained. Photographs were taken from the reference positions.

At monthly intervals for six months following the burns, the photographs of selected components of

vegetation were taken from the reference positions. Checks of animal (almost entirely insect) browsing of leaves were made to confirm that this remained at a low level (less than 5%) so that leaf changes could be attributed to fire effects.

Six months after the burns (March), the following were recorded for all tagged individuals: species (a recording check); live or dead state of plant; canopy live or dead; height of top parts of canopies; diameter of stem at 20 cm above ground level (for all stems >1.0 cm diameter); number of new basal shoots; number of old basal shoots still present; number of basal shoots killed by the fire and still present; number of old dead basal shoots that survived the fire; estimation of proportion of original canopy volume dead (this was difficult to apply in species



FIG. 3.—A *Grewia flavescescens* shrub (with pole): a, on 5th September, before the burn, showing basal regeneration commencing, after virtual total removal of aboveground material by the burn; b, on 5th October, one month after the burn; c, on 7th November, two months after the burn showing basal regeneration at an intermediate stage; d, on 18th December, more than three months after the burn showing basal regeneration virtually complete; e, on 3rd January; f, on 6th February demonstrating that virtually all basal regeneration is completed by the December date. The shrubs on the left of the marked *Grewia* individual are *Euclea natalensis* which regenerated more strongly than did the *Grewia* individuals.

such as *Grewia flavescens*, where the original outline of canopies was usually altogether lost through fire (Fig. 3); biomass of basal twig regeneration (clipped at ground level); biomass of basal leaf regeneration; biomass of all leaves in canopy (for individuals ≤ 5 m height). All biomass data were obtained oven dry at 85°C and total sampling was used, that is, no subsampling was employed.

The diameters of stems were taken for use in already established formulae that predict canopy leaf mass (Rutherford, 1979). These regression formulae were first tested by destructive sampling for each of the more common species in the unburnt control populations since the formulae were derived for populations several kilometres distant and three years previous to the time of fire. If, as was found in the *Ochna pulchra* population, there was very good agreement between predicted canopy leaf mass and actual destructively sampled canopy leaf mass of the unburnt population, the regression formula was applied to the burnt population of the appropriate species (using original plant height if height was reduced by fire) to obtain expected leaf mass had the population not been burned. Therefore, on condition that the regression formulae still proved suitable, this procedure provided a more sensitive measure of the degree of canopy leaf biomass reduction by fire than that provided by using treatments and controls which sometimes had greatly differing distributions of heights within each height class. Canopy leaf biomass reduction per height class was thus calculated in these cases by taking the predicted unburnt canopy leaf biomass of the burned individuals and subtracting the actual canopy leaf biomass obtained by direct harvest from the burned individuals.

It should be noted that for practical reasons a small proportion of the individuals included in the sample for numerical counts of stems, mortality and so on were not harvested for biomass. Therefore those numerical non-biomass data concerning differences before and after the fires are not necessarily precisely interrelateable with the biomass data set since there are possible differences in plant size distribution in the whole sample set and in the biomass data subset.

Only some data are tabulated since tabulation of all data for all species, all plant size classes and all the types of possible fire effects, results in many large tables with very many empty cells. This difficulty is inherent in studies such as the present, and arises not only from variation in the natural vegetation composition and structure but also from the inapplicability of some measures of the effects of fire to certain plant growth forms. The very unbalanced total data set resulted in no full analysis of variance being attempted. Instead, for categories where sufficient data existed, all data from the category were used in standard statistical tests of significance between means, often using the non-parametric Wilcoxon test where appropriate. Most data are indicated graphically where use was made of data grouped into classes in the presentation of relations.

4. RESULTS

a) Mortality/survival of plants after the burns

Mortality was defined as the proportion of the number of plant individuals that were alive before the fire but dead (above ground) six months after the fire ('Root kill' of Niering *et al.*, 1970). It is possible that mortality includes individuals that survived or regenerated after fire but died from other causes within the six month period following the fire.

That mortality of unburned individuals would be close to zero was confirmed by the data for the control that showed a mortality of 1% of the tree species group's individuals and 0% of the multistemmed shrub species group's individuals. In the slower burn area mortality of the tree species individuals was 5% which was significantly greater ($P=0.005$) than that of the unburned control. For the shrub species individuals mortality was 0%. In the faster burn area mortality of the tree species individuals was 2% which was not significantly different from that of the control. The mortality of the multistemmed shrub species individuals was significantly greater than that of the unburned control. This mortality is, however, subject to further interpretation since one species was involved, namely, *Dichapetalum cymosum*, where a mortality of 64% for its individuals up to 25 cm tall was indicated. Re-examination in August of most of these individuals recorded as dead in March showed that although most had no aboveground parts visible there were live belowground parts that were in the process of initiating new shoot growth. In these cases, therefore, fire possibly only delayed new growth by one growth season. However, given the extensive underground branching and interconnections between 'individuals' of this geoxylic suffruticose species, new regenerative growth possibly occurred after the fire but not in the immediate vicinity of the labelled 'individual'. Rushworth (1978) also found that woody suffrutices such as *D. cymosum* did, contrary to other woody plants, not produce additional stems per plant unit after fire in Wankie National Park, Zimbabwe. That the high mortality of 'individuals' of *D. cymosum* is merely an apparent mortality, means that, in fact, the mortality values for the multistemmed shrub species individuals was very close to zero.

Despite individuals of *Grewia flavescens* having the highest fuel loads within the plant and that many plants were completely consumed by the fire (Fig. 3), there was no mortality within these populations in either burn. Mortality of *Ochna pulchra* plants in the slow burn (5%) was significantly greater ($P=0.005$) than that in the faster burn (1%). However, when grouped into plant height classes (Table 2) there was no significant difference in mortality for those plants taller than 0.25 m but only for the group below 0.25 m height. In *Burkea africana*, mortality was limited to small plants under 10 cm tall, that is, 54% for those of both burns. Most of these plants killed were seedlings.

b) Effects of fire on plant canopies

Plants were defined as canopied where leaves were carried on stems more than one year old. Non-canopied individuals were thus made up of only (young) basal shoots whereas canopied individuals had an older main stem bearing the canopy leaves with or without basal shoots present. Because of some difficulties in ageing basal shoots before the burns a few non-canopied individuals possibly had basal shoots slightly older than one year but such basal shoots were morphologically similar to one-year old shoots. The effects of the burns on canopies are of course limited to the canopied plants. The effects of fire on canopies can be expressed in various ways, depending upon the canopy attribute considered. Canopy mortality occurs where the whole canopy dies, but where the plant still survives in the form of basal regeneration shoots ('Stem kill' of Niering *et al.*, 1970) (Fig. 4). The occurrence of abnormal leaf growth refers to the amount of leaves

TABLE 2.—Mortality of woody plant individuals following fire according to plant height class

Plant Height Classes (cm)	Tree Species Group		Control (%)	Multistemmed Shrub Group		Ochna pulchra	
	Slow burn (%)	Fast burn (%)		Slow burn (%)	Fast burn (%)	Slow burn (%)	Fast burn (%)
0 – 9,9	13	9	0	0	69	12	0
10 – 24,9	7	0	0	0	60	8	0
25 – 49,9	0	1	5	0	0	0	0
50 – 99,9	5	0	0	0	0	0	0
100 – 149,9	0	5	5	0	0	0	9
150 – 199,9	0	0	0	0	0	0	0
200 – 249,9	6	6	0	0	0	6	7
250 – 499,9	2	0	0	0	0	0	0
>500	0	0	0	—	—	0	0
All	5	2	1	0	38	5	1

that have grown in a convoluted manner and are usually produced not from terminal twigs but from thicker, older wood parts (Fig. 5). Also in terms of shoot extension in Ugandan savanna, Harrington (1974) refers to the tops of taller burned bushes behaving similarly to bushes in an unburnt controlled treatment. Changes in the height and canopy volume of plants refers to measurements as described in the section on methods. Another attribute used is the change in the total amount of leaf biomass in the canopy.

i) Canopy Mortality

Only 0,7% of the unburned control tree species plants' canopies died. In the faster burn, 43,2% canopies were killed of which 92,1% were under 2 m tall with none taller than 5 m. In the faster burn, these plants up to 1,5 m tall had 9,2 canopies killed to each one that survived. For those over 1,5 m tall there were only 0,2 canopies killed for each surviving canopy. In the slower burn, 23,5% canopies were killed of which 90,1% were under 2,5 m tall and also

with none taller than 5 m. In the slower burn, those plants up to 1 m tall had 1,6 canopies killed for each one that survived. For plants between 1 and 1,5 m tall the ratio was about 1 : 1 while for those more than 1,5 m tall there were also only 0,2 canopies killed for each surviving canopy. Relative to the control tree species plants, therefore, canopy mortality in both burns was highly significant particularly for individuals less than 2 or 2,5 m tall.

In the *Ochna pulchra* population, canopy mortality was 32,0% in the slower burn and 44,1% in the faster burn. Only in one species, namely *Vitex rehmannii* was it clear that tall individuals had a relatively high canopy mortality, that is, 64,3% for individuals between 2,5 and 5,0 m tall. Despite the sensitivity of canopies of *V. rehmannii* to fire, no plants of this species died after fire. The hollow main stem of one tree individual, *Securidaca longipedunculata*, was observed to burn vigorously for several hours after the main flame front had passed, but at the end of the growth season the canopy showed no obvious effects of the fire (Fig. 6).

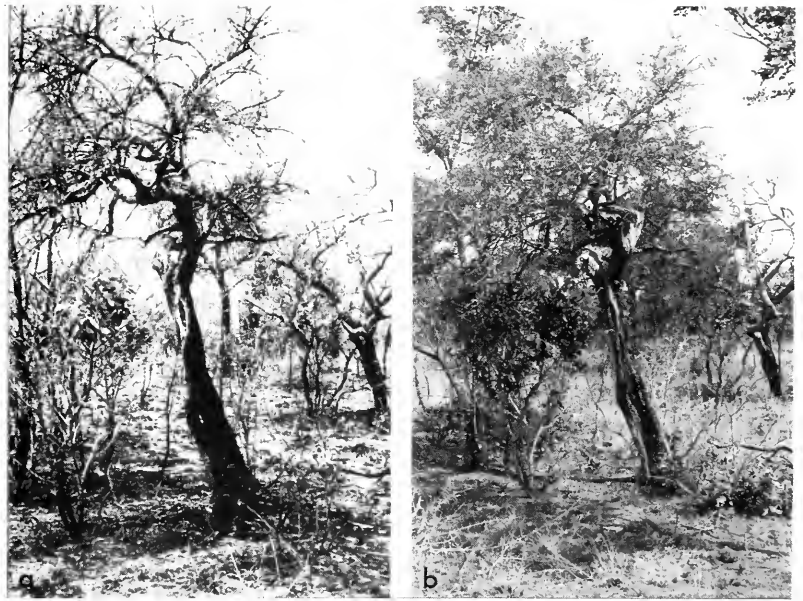


FIG. 4.—A group of *Ochna pulchra* individuals with most canopies killed by the burn but with prolific basal regeneration.

FIG. 5.—a, An *Ochna pulchra* individual showing areas of missing foliage in lower parts of former canopy and the predominantly normally formed leaves at the extremities of the highest branches; b, an *Ochna pulchra* individual showing reduction of foliage in former canopy areas and the predominantly abnormally formed leaves clustered and produced directly from areas of thicker branches and stem and not at the branch extremities.



FIG. 6.—A *Securidaca longipedunculata* tree: a, one day after the burn (6th September) with a hollow stem that was observed to burn vigorously for several hours after the burn; b, five months after the burn (6th February) indicating the canopy that shows no obvious reduction and appears as unaffected as that of a normal unburned individual of this species.



ii) Occurrence of abnormal canopy leaf growth

Apart from observing that the incidence of abnormal canopy leaf growth was generally higher in the faster burn than in the slower burn, the mere presence of abnormal leaf growth was found to be less informative than the actual value of abnormal leaf biomass compared to that of normal leaf biomass. Since a clear qualitative recognition of this abnormality is required for expressing such ratios, consideration was limited to the *Ochna pulchra* population where such distinction was most reliable (Fig. 5). The ratio of normal to abnormal canopy leaf biomass was found to increase exponentially with plant height (Fig. 7) and is discussed further in Section 4e.

iii) Changes in canopy height and canopy volume

For the unburned tree species control plants, mean change in height was +4% with the greatest relative reduction in any height class being -2%. Although in unburned plants height appeared to be unimportant in affecting tree height changes, in both burns canopied plants of the lowest height classes had the greatest relative reduction in height (about 100%) with tallest plants having a zero reduction in height. The relative decrease in plant height after the faster burn was greater for each height class than that for the slower burn, for example in *Ochna pulchra* (Fig. 8a). In terms of the proportion of plants that decrease in canopy height it was found, for tree

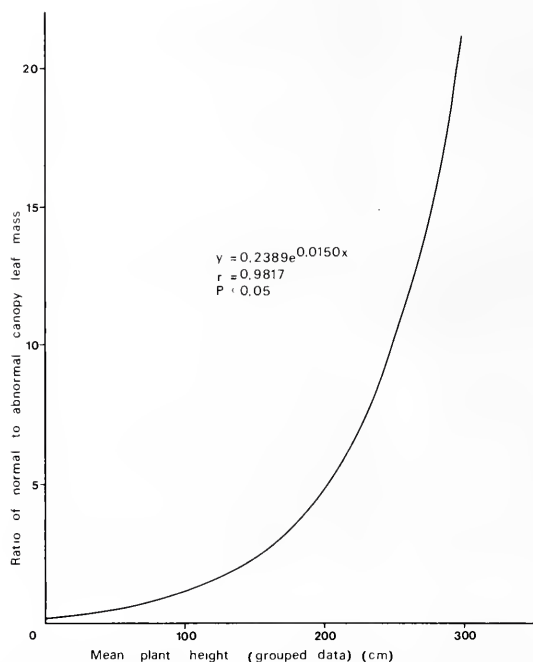


FIG. 7.—Relationship between mean plant height and the ratio of the mass of normally to abnormally formed canopy leaves for *Ochna pulchra* in both burns.

species plants, that 5% of unburned plants, 28% of the plants of the slower burn and 50% of the plants of the faster burn decreased in height. There was therefore a similar pattern with a greater proportion of individuals decreasing in height in the faster burn area (Fig. 8b). A very similar pattern was obtained in terms of reduction in estimated canopy volume (Fig. 8c). In the multistemmed shrub species group, changes in height were more variable and less strongly correlated with height.

iv) Changes in canopy leaf biomass

Effects of the burns on the canopy leaf biomass could be determined as described earlier on the basis of application of allometric biomass prediction formulae once appropriate tests of the validity of application had been made. It was found that the allometric formulae, applied to unburned plants (stem diameter ≥ 1 cm at 20 cm height) of *Ochna pulchra*, overestimated the actual harvested canopy leaf biomass value by only 0.1%. In *Terminalia sericea* it was found that canopy leaf mass was underestimated but remained within 20% of the actual harvested amount. In *Burkea africana* it was found that canopy leaf mass was overestimated by more than 20% (in the relatively small tested sample population of the control) and the biomass prediction formulae were thus not applied to the burned *B. africana* populations. Since the allometric formulae could not be applied to the smallest individuals, canopy leaf biomass data from unburned control plants were utilized for the lowest size classes.

In the slower burn area, *Ochna pulchra* plants under 1 m tall decreased in canopy leaf biomass by 90%, but this reduction became less marked with taller plants so that a decrease of only 26% was found for plants between 2.5 and 5 m tall. In the faster burn area the plants under 1 m tall decreased in

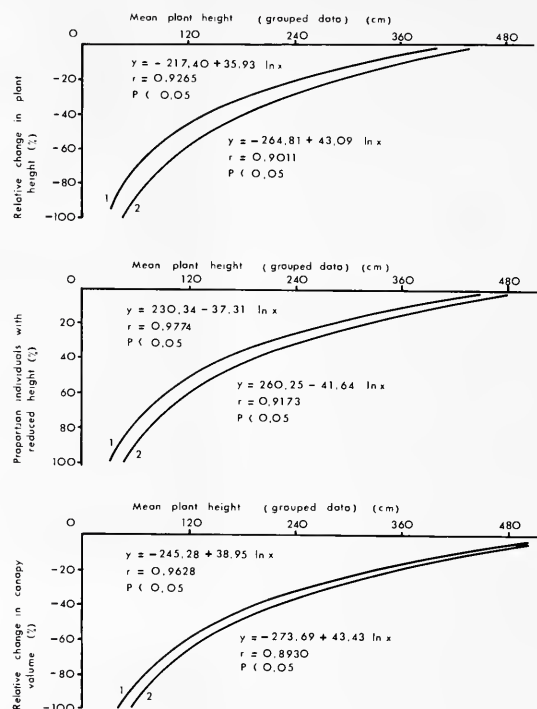


FIG. 8.—Relationships between mean plant height and: a, relative change in plant height; b, proportion of individuals that decrease in height (graph inverted for comparison); c, relative change in canopy volume for *Ochna pulchra* in (1) the slower burn and (2) the faster burn.

canopy leaf biomass by 92%, and this also became less marked with taller plants but with a 50% decrease for plants between 2.5 and 5 m tall.

In *Terminalia sericea* of both burns, trees ≥ 2.7 m tall had a canopy leaf biomass of 79% of that predicted, but for the smaller trees only 6% of the predicted value. This contrasts with the 83% of that predicted in the unburned control plants. Therefore, allowing for the shift in the prediction equation (given by the control), a reduction of at least 90% in canopy leaf mass after fire occurred for the *T. sericea* plants less than or equal to 2.6 m tall. In *Burkea africana* of both burns, stem basal area was used as a measure of plant size to relate to the harvested canopy leaf biomass. For trees up to a cross-sectional stem basal area (at 20 cm height) approaching 50 cm² canopy leaf biomass was less in burned plants than unburned plants, but for plants with a basal area of about 50 cm² or more this difference no longer held (Fig. 9). For taller plants (approximately greater than 2.5 m) *Ochna pulchra* had a greater canopy leaf biomass reduction than *Terminalia sericea* and *Burkea africana*. For smaller plants the differences were less pronounced between these three main tree species.

c) Effect of fire on basal shoot numbers

Most basal shoots that were live before the burns were killed by the fire. Although 14% of the basal shoots of control tree species plants died without fire, 91% were killed in the slower burn and 100% in the faster burn. The killing of live basal shoots by fire was independent of plant height and species. In the multistemmed shrub species plants killing of live basal shoots was virtually 100% in both burns.

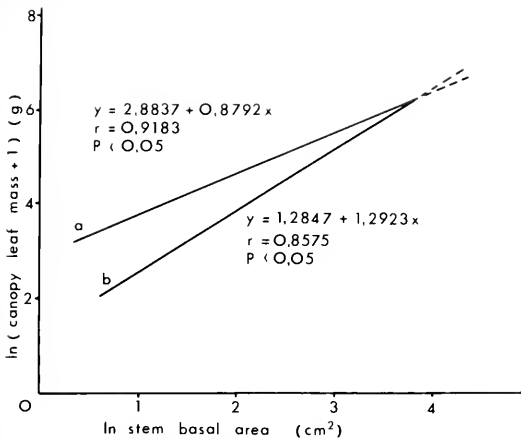


FIG. 9.—Relationship between stem basal area and canopy leaf mass for: a, unburned individuals; b, burned individuals in both burns for *Burkea africana*.

The formation of new post-fire basal shoots was a common phenomenon in burned individuals (Figs. 10 & 11) and these were virtually completely grown by December, that is, about three months after the burn (Fig. 3). Whereas a mean of 0.09 new basal shoots were formed per unburned control plant, the corresponding values were 2.42 for the slower burn and 4.55 for the faster burn. In the unburned control plants, however, new basal shoots were not formed from individuals more than 1 m tall, whereas in burned individuals these were formed irrespective of plant height, but with a tendency for fewer basal shoots to be produced per tall individual. In the multistemmed shrub species plants approximately 5% of the unburned individuals produced new basal shoots, whereas corresponding values were 93% in the slower burn area and 100% in the faster burn area.

The possible relationship between the number of live basal shoots before the fire and those formed after the fire was investigated to determine to what

FIG. 10.—Basal regeneration shoots of *Ochna pulchra* on 18th December after above-ground shoots had been either killed or removed by the burn.



FIG. 11.—Basal regeneration shoots of *Grewia flavescens* on 3rd January after all above-ground shoots had been killed and almost all removed by the burn.



degree live basal shoots were replaced after fire. Data were expressed as the ratio of the number of new basal shoots to the number of old basal shoots killed by the fire. In *Ochna pulchra* basal shoots killed were replaced by almost twice (1,88) the number of new basal shoots. In *Burkea africana* the ratio was only 1,30 which was, however, still a net increase of basal shoots per plant.

In *Ochna pulchra*, although the number of new basal shoots tended to decrease with increasing plant height class, it was found that replacement of basal shoots increased with increasing plant height. No such trend was discernible in *Burkea africana*. The basal shoot replacement relation is given in Fig. 12 for the mean of both burns. The degree of ability of these plants to produce new basal shoots after fire appears to depend on not only the size of the plant, but also on the number of basal shoots prior to the fire.

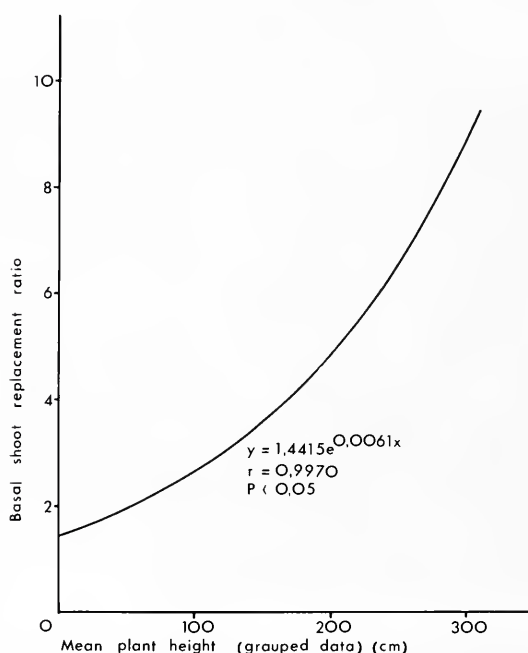


FIG. 12.—Relationship between mean plant height and the ratio of number of post burn basal regeneration shoots to number of pre-burn live basal shoots (basal shoot replacement ratio) in *Ochna pulchra*.

d) Effect of fire on production of new basal regeneration shoot biomass

Basal shoot production (over the 6 month period following the burns) averaged per individual from both burns was 9,59 g for *Ochna pulchra*, 14,52 g for *Burkea africana* and 1,09 g for *Terminalia sericea* (Table 3). In each of these populations, basal regeneration shoot mass of unburned plants was usually considerably less than 10% of basal mass in burned plants. This was also valid for the rarer species, but in some there were very small sized samples for the control, for example, there was no *Dichapetalum cymosum* in the control area. From Table 3 it can be seen that species with low values (<10 g) for basal regeneration shoot mass per individual were *Dichapetalum cymosum*, *Terminalia sericea*, *Strychnos pungens* and *Ochna pulchra*. The

species with highest values (>50 g) were *Grewia flavescens*, *Dombeya rotundifolia* and *Vitex rehmannii* with *Euclea natalensis* having the highest value of all (285,62 g). Those species with greatest basal regeneration shoot mass tended to be non-suffrutex shrub forms whereas tree growth forms usually had relatively low basal regeneration shoot mass.

In terms of mean biomass of basal shoots per individual shoot (where these were clearly distinguishable), *Lannea discolor* and *Burkea africana* had highest values while lowest values were found in *Dichapetalum cymosum* and *Terminalia sericea*.

Species may be divided into three groups according to their ratio of basal leaf mass to basal twig mass. Those with a ratio of less than 1, that is, there was more twig mass than leaf mass, included *Securidaca longipedunculata* and *Terminalia sericea*. Those with up to twice the amount of leaf mass to twig mass included the largest number of species. Those with more than twice as much leaf mass as twig mass included the two most important geoxylic suffrutex species *Dichapetalum cymosum* and *Fadogia monitcola*.

Differences in mean basal shoot regeneration mass between different species were tested (for all species with more than 3 individuals) often using the non-parametric Wilcoxon test where appropriate (Table 4). At a level of significance of $P=0,05$ more than half the combinations were significantly different. Since the reaction of *Grewia flavescens* was so different in two burns, these were treated separately.

In *Ochna pulchra* in the slower burn, basal shoot regeneration per individual (4,86 g) was significantly lower than that (12,28 g) in the faster burn. In *Grewia flavescens* the corresponding values were 65,00 g and 160,02 g. This greater production of basal regeneration shoot mass in the faster burn area was also confirmed in *Burkea africana* for each height class of individuals. In *Grewia flavescens*, the live basal shoot mass per unburned individual was significantly greater ($P=0,005$) than the post fire regeneration basal shoot mass in the slower burn area, but there was no significant difference to that produced in the faster burn.

The possible relationship between degree of burn recorded in both burns and basal regeneration mass of the woody plants was shown by 63,73 g for those recorded as burned, 115,12 g for those recorded as severely burned and 107,68 g for those completely burned.

The species with the greatest range in basal regeneration shoot mass was *Euclea natalensis* (1,74 to 1143,37 g). When the population was divided into three equal size classes that is up to 0,5 m tall, 0,5–1,0 m and 1,0–1,5 m tall, the respective mean masses were 40,44 g, 248,38 g and 768,72 g and each value was significantly different from the other. There was thus a clearly greater basal shoot regeneration mass with increased plant size for this shrub species.

It was noted during observations that the individual leaf size, especially of *Ochna pulchra*, was markedly larger in basal regeneration shoots than in the canopy.

e) Relationships between plant height and woody plant biomass components after fire

Earlier reference has been made to effects of the burns on plant height and canopy volume in *Ochna pulchra* and to effects on canopy leaf mass in *Burkea*

TABLE 3.—Basal regeneration shoot mass data for the more common woody plant species

Species	Mean basal regeneration shoot mass per individual (g)	Mean mass per shoot (g)	Basal leaf/twig mass ratio
<i>Dichapetalum cymosum</i>	0,70	0,67	4,35
<i>Terminalia sericea</i>	1,09	1,05	0,45
<i>Strychnos pungens</i>	3,07	—	1,44
<i>Ochna pulchra</i>	9,59	2,56	1,47
<i>Securidaca longipedunculata</i>	10,16	1,95	0,31
<i>Burkea africana</i>	14,52	9,77	2,88
<i>Fadogia monticola</i>	16,37	3,74	2,37
<i>Lannea discolor</i>	45,61	20,73	0,86
<i>Grewia flavescens</i> (slow burn)	65,00	—	1,40
<i>Dombeya rotundifolia</i>	67,65	4,10	1,20
<i>Vitex rehmannii</i>	89,13	—	1,30
<i>Grewia flavescens</i> (fast burn)	160,02	—	1,40
<i>Euclea natalensis</i>	285,62	—	2,14

TABLE 4.—Statistical significance of differences in basal regeneration shoot biomass of different woody plant species after fire

Acacia caffra													
Burkea africana													
Combretum molle													
xxx	x	xxx	Dichapetalum cymosum										
	xxx		xxx	Dombeya rotundifolia									
	xxx		xxx	xxx	Euclea natalensis								
			xxx	xxx	xxx	Fadogia monticola							
x		x	xxx		xxx	xxx	Grewia flavescens (Slow burn)						
x		x	xxx	xxx		xxx	xxx	Grewia flavescens (Fast burn)					
	x		xxx			xxx		x	Lannea discolor				
	x		xxx	xxx	xxx	xx	xxx	xxx	xxx	Ochna pulchra			
			xxx	x	x		xxx	xxx	x		Securidaca longipedunculata		
			xxx					x			Strychnos cocculoides		
xxx	xxx	xxx		xxx	xxx	xxx	xxx	xxx	xxx	x	xxx	Strychnos pungens	
xxx	x	xxx		xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx		Terminalia sericea
		x	xxx			x		x		xxx	x	xxx	Vitex poare
xx	xxx	xx	xxx		xxx	xxx		xx	x	xxx	xxx	x	Vitex rehmannii

xxx : P < 0,005

xx : P < 0,01

x : P < 0,05

africana according to stem basal area. The present section aims to determine to what extent plant height governs changes in various plant biomass components after fire.

When basal leaf mass is compared to canopy leaf mass in *Ochna pulchra* it is found that the ratio of canopy leaf mass to basal leaf mass increases non-linearly with increasing tree height (Fig. 13). Plants under 1 m tall have more than half their leaf mass in the form of basal leaves; plants around 1 m tall have basal and canopy leaf mass about equal, while in

plants taller than 1 m canopy leaf mass becomes rapidly much greater than basal leaf mass.

In *Ochna pulchra* it was found for both burns together that the ratio of normally formed to abnormally formed canopy leaf mass increased exponentially with plant height (Fig. 7). For plants about 1 m tall abnormally formed leaf mass more or less equalled normally formed leaves. For plants above 1 m tall, normally produced leaf mass quickly became many times that of the abnormally produced leaf mass. In the faster burn plants, abnormally formed leaves

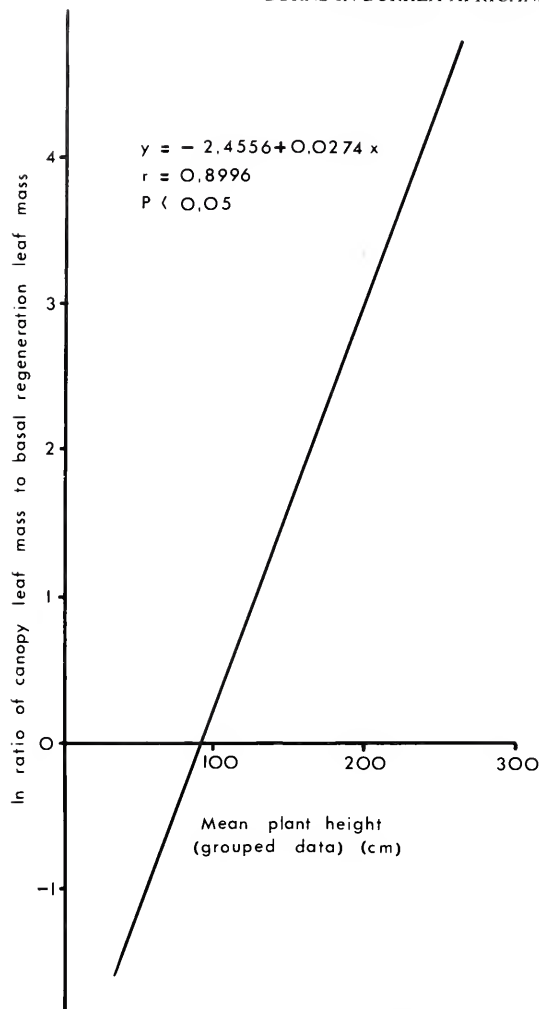


FIG. 13.—Relationship between mean plant height and \ln the ratio of canopy leaf mass to basal regeneration leaf mass for *Ochna pulchra* in both burns.

contributed relatively more than in the slower burn. In the faster burn, extreme values for the ratios were also obtained, that is zero for the lowest height class and ∞ for the highest height class.

Differences in leaf mass between burned and unburned *Ochna pulchra* for both burns for each height class are indicated in Fig. 14. It can be seen that an increasing proportion of canopy leaf mass was lost after fire with decreasing plant height to a point where plants were too small to be canopied. The relationship approximates an exponential decay curve where the percentage change in canopy leaf mass decreases exponentially with lower plant height. However, in contrast to this monotonic relationship, an increasing proportion of total leaf mass is lost with decreasing height only until a height of 1–1.5 m is reached, thereupon a maximum reduction in total leaf mass having been attained, less leaf mass is lost until for smallest plants the mean total leaf mass becomes a net increase. It is also clear that it is those plants roughly 0.75–2.5 m tall, that on average have more than 50% of total leaf mass reduced by fire whereas for the smallest and largest individuals this was not so.

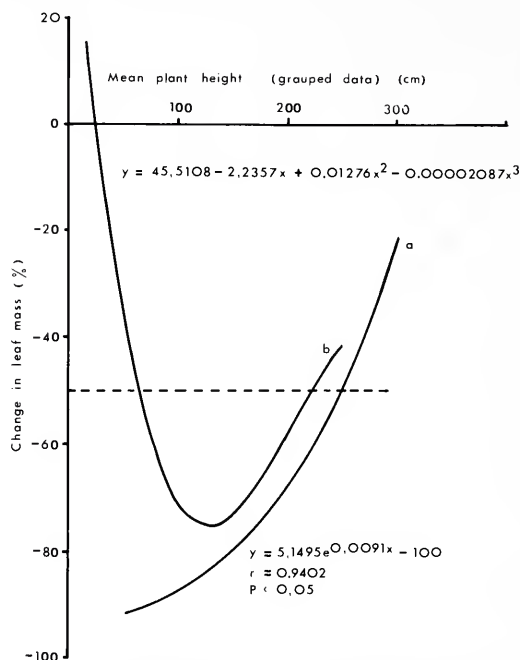


FIG. 14.—Relationship between mean plant height and: a, change in canopy leaf mass; b, change in total plant leaf mass for *Ochna pulchra* in both burns. The broken line indicates the points at which leaf mass is reduced by more than half of the total amount.

It was found that in *Ochna pulchra*, there was an increase in basal regeneration shoot mass with height until a maximum was reached for heights about 1 to 1.5 m after which there was a decline in basal regeneration shoot mass with plant height (Fig. 15).

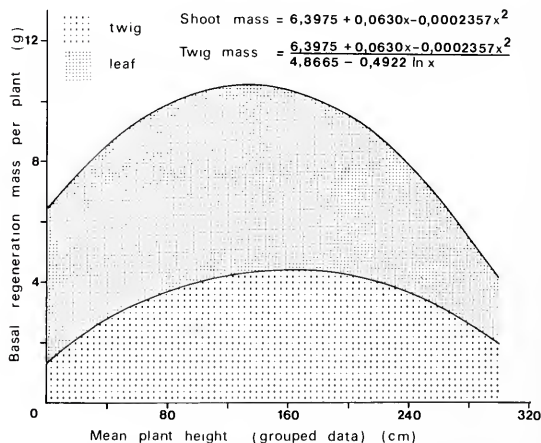


FIG. 15.—Relationship between mean plant height and basal regeneration mass showing the relative contributions of leaf and twig mass for *Ochna pulchra* in both burns (shoot mass = leaf mass + twig mass).

A relationship between plant height and the ratio of leaf mass to twig mass of the basal regeneration shoots was found for both *Ochna pulchra* and *Burkea africana* (Fig. 16). This inverse relationship

assumed the form of a logarithmically decreasing ratio with increasing tree height. There was very little distinction in the relationship between the two burns in *Ochna pulchra*. The ratio in *Burkea africana* was generally much higher than that for *Ochna pulchra* for each height class. This inverse relationship is very different to that in canopies of unburned *Ochna pulchra* where there is no such inverse relationship with plant height.

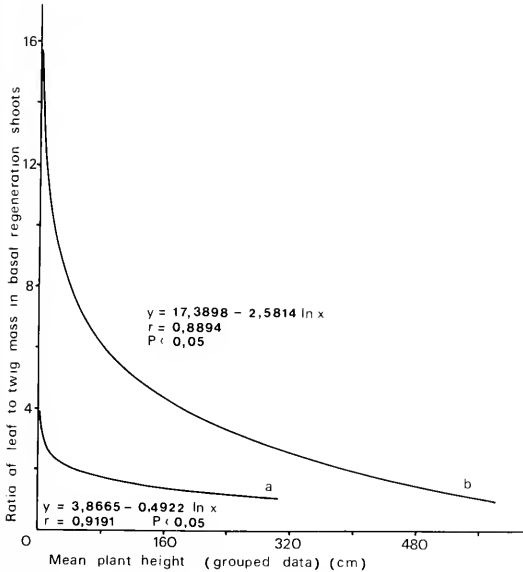


FIG. 16.—Relationship between plant height and the ratio of leaf to twig mass in basal regeneration shoots of: a, *Ochna pulchra*; b, *Burkea africana* in both burns.

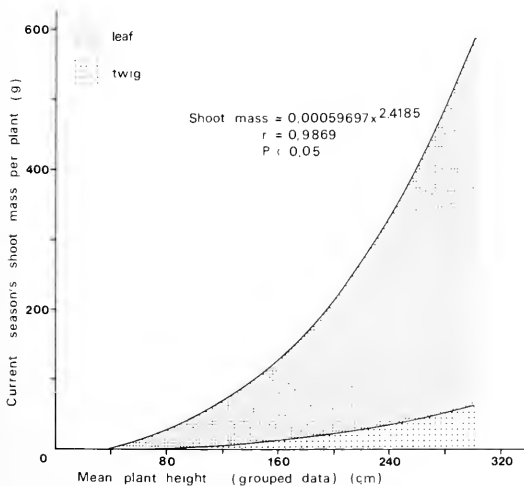


FIG. 17.—Relationships between mean plant height and current season's shoot mass showing the relative contribution of leaf and twig mass for unburned *Ochna pulchra*.

Combining the above inverse relationship equation for *Ochna pulchra* (Fig. 16) with the parabolic dependence of basal shoot mass on plant height, the result is given in Fig. 15. This may be contrasted with corresponding data in normal canopies (Fig. 17),

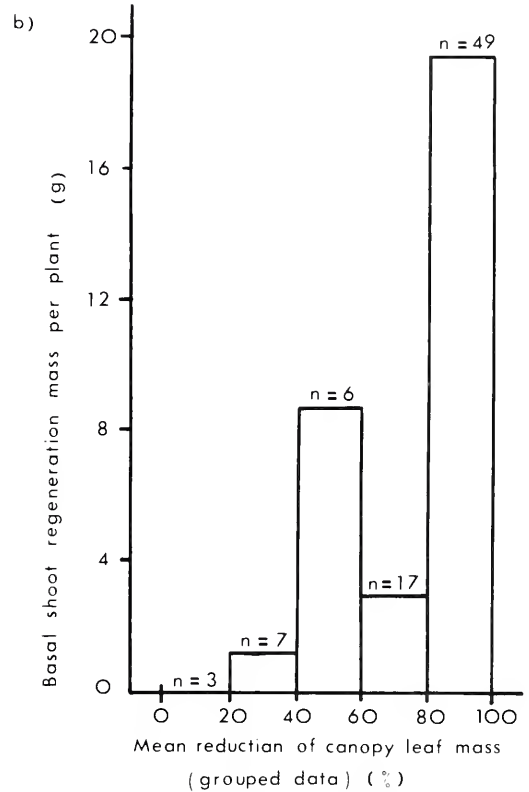
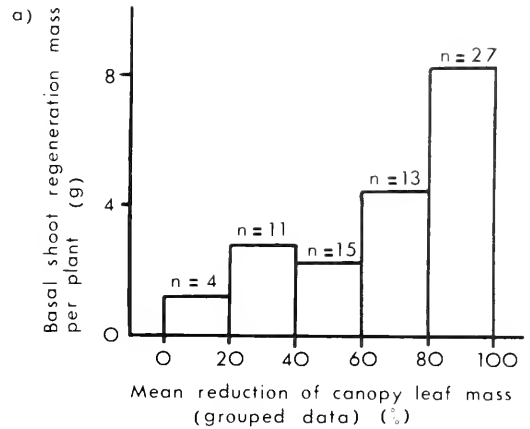


FIG. 18.—Histogram of reduction in *Ochna pulchra* canopy leaf mass against basal regeneration shoot mass per plant in: a, the slower burn; b, the faster burn. n equals the number of individuals in the sample.

obtained from randomly selected Nylsvley individuals and from published allometric biomass relations (Rutherford, 1979). It is clear that (i) the form of the relations; (ii) the relative proportion of components and (iii) changes in this proportion with plant height all differ radically between *O. pulchra* basal regeneration shoots after fire and the normal canopy shoots.

f) Other pyro-allometric biomass relations

In previous sections, much evidence has been given to show that the more damage the canopy of, for ex-

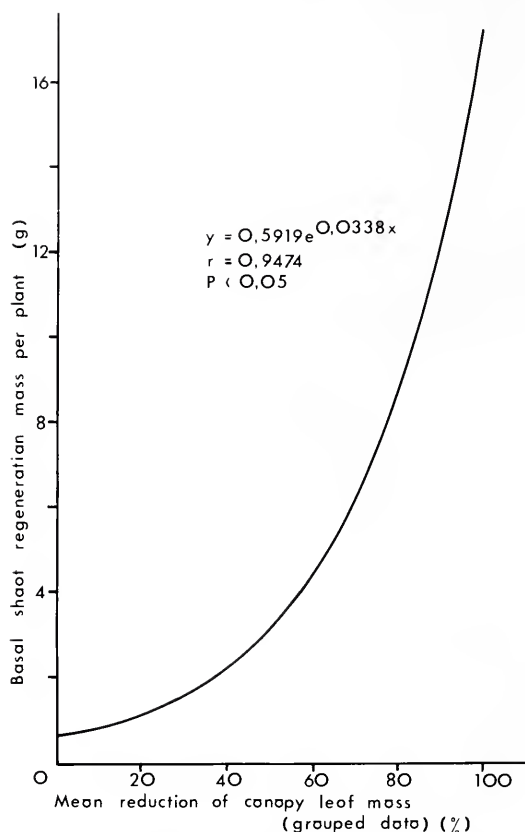


FIG. 19.—Relationship of reduction in *Ochna pulchra* canopy leaf mass and basal regeneration shoot mass per plant in both burns.

ample, *Ochna pulchra*, is subjected to, the greater the amount of basal regeneration. Now using the relative reduction in leaf biomass of canopies as a measure of canopy damage this is related to basal shoot regeneration mass to provide a more precise relationship. In deriving these relationships, individuals that were completely killed by the fire were omitted as were the very few individuals that actually increased slightly in canopy leaf mass after fire. Grouping all plants (of all heights) of *O. pulchra* into five equal classes of relative reduction in canopy leaf mass, generally increased basal shoot mass with classes of increasing reduction in canopy leaf mass (Fig. 18) was apparent in both burns. Expressed as a relation (Fig. 19) it was found that there was an exponential increase in basal shoot production with an increasing proportion of canopy leaf mass lost through fire (until a few individuals pass beyond a certain threshold and die). Particularly for the uppermost canopy leaf mass reduction class, the plants of the faster burn area produced a greater mass of basal regeneration shoots than those of the slower burn.

Although basal shoot regeneration mass was found to increase with increased damage to canopies, the concept should possibly not be extended to very small (<0.25m height) uncanopied plants of *O. pulchra*. Using the recorded degree of burn as a measure of damage to these plants, it was found that plants recorded as burned had a mean shoot mass of 10.35 g, whereas those recorded as severely or completely burned had a mass of only 5.37 g, which is significantly ($P = 0.005$) lower.

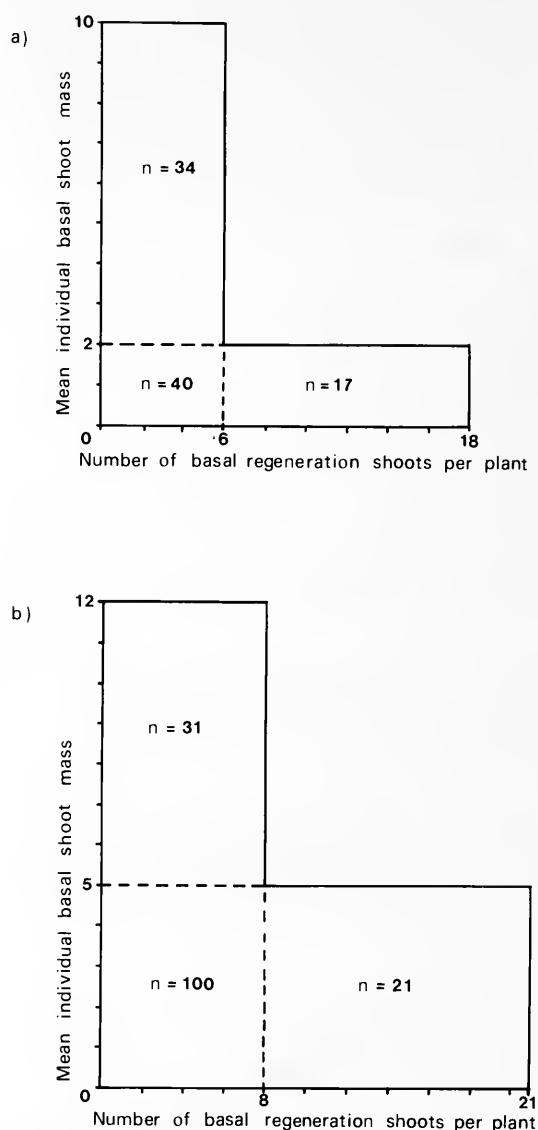


FIG. 20.—Distribution of plants of *Ochna pulchra* relative to both number of basal regeneration shoots and mean individual basal shoot mass for: a, the slower burn; b, the faster burn. n is number of plants.

Another feature that emerged for *O. pulchra* of both burns was not only an inverse but an approximately rectangular hyperbolic relation between number of basal regeneration shoots and the mean mass per basal shoot. In the slower burn area the data set was more tightly grouped (Fig. 20a) in that there was no occurrence of individuals with both more than 6 basal shoots and a mean shoot mass of more than 2 g. In the faster burn area (Fig. 20b), although the distribution was still hyperbolic, the data were more variable. In both these distributions, plant height appeared not to be important.

g) Effects of fire on standing dead individuals

Of the 45 dead standing woody plants labelled before the fire (including controls), most belonged to *Ochna pulchra*, *Burkea africana* and *Terminalia*

sericea. No significant differences in the fire effects between the two burns were found for these dead plants. The effects of fire on the height of dead standing individuals was found to tend strongly to one of two extremes, namely no reduction in height (69%) or maximum reduction to ground level (24%). All those individuals felled by the fire were under 1.5 m tall, that is, no individuals over 1.5 m tall were felled by the fire despite the observed active burning at the base of two of these a day after the fire. Eighty-six percent of those felled by fire were totally consumed. Although 24% of burned individuals were felled, this was not much higher than the 19% of individuals that fell over in the absence of fire in the six month period. There was no apparent selectivity of felling of individuals by fire or other agents according to plant species. In the main live sample individuals, basal shoots that were dead before the burn were almost always totally consumed by fire. Woody plant leaf litter on the ground, although inflammable, sometimes did not ignite fully, for example, even in thick layers in *Ochna pulchra* patches, burning was often limited to very superficial surface layers of leaves (Fig. 21).

5. DISCUSSION AND CONCLUSIONS

In keeping with common veld management practice, the experimental burns were carried out in early spring when the various deciduous plant populations were at different stages of bud break development. Although stage of bud break development at which the plant is burned may be considered possibly critical to the subsequent fire effects measured, data of Hopkins (1963) for work on selected tree species in south-western Nigerian savanna, appear to indicate that burning in the period of a few weeks before and after normal bud break, does not markedly change the period needed for recovery to start.

a) Mortality/survival of plants after the burns

That mortality was significant only in the slower burn and was also largely limited to very low tree

species plants, indicates that the effects of a slower head fire may differ to those of a faster head fire in a way similar to the different effects between a back burn and a head burn at ground level in grassland (Trollope, 1978). The apparently anomalous lower mortality with greater damage to the canopy in the faster burn, relates to the compensatory basal regeneration effect described. Therefore, even in a faster fire, with a probably more intense overall heat than in the slower burn, the mortality effects may relate to more intense heat nearer the ground and not to heat loads at canopy level. Even where fire was reported with wind twice the speed of that in the present study, mortality remained low (Stransky & Halls, 1979).

That most species in the present study had mortality after fire varying from 0 to 5% shows a fire tolerance that appears common in many other woody plants in Africa. The limitation of mortality in *Burkea africana* to very low plants, mainly seedlings, agrees well with Jackson's (1974) classification of it as a pyrophytic species. The quoted fire 'tolerance' or 'resistance' (Trapnell, 1959; Van Wyk, 1971; Lawton, 1978) for *Dichrostachys cinerea*, *Dombeya rotundifolia*, *Lannea discolor*, *Strychnos pungens* and *Terminalia sericea* is confirmed by the less than 5% mortality for each in the present study. *Ochna pulchra* was also shown in this study to be generally fire tolerant in agreement with indications of Lawton (1978) and Rushworth (1978) but not with a 'fire-sensitive' description (Geldenhuys, 1977).

The very low mortality rate after fire of multi-stemmed shrubs (omitting *Dichapetalum cymosum*), which includes the 0% mortality of *Grewia flavescens* despite its relatively high fuel loads, is paralleled in eastern Cape *Acacia karroo* Savanna where only the multistemmed plants of *Rhus lucida* recovered fully after a fire (Trollope, 1974).

b) Effects of fire on plant canopies

Data from the present study clearly show the considerable effect of fire on woody plant canopies, par-



FIG. 21.—A typical thick (> 5 cm) layer of leaf litter under a patch of *Ochna pulchra* individuals: a, before the fire (5th September); b, after the fire (6th September) showing the low degree of litter burn with only a superficial layer of the litter being burned or singed. Temperature tempil plates are visible.

ticularly of the smaller plants and these findings broadly agree with results from other areas.

Whereas a two-thirds decrease in canopy volume corresponded to trees and shrubs under 5 cm DBH in *Burkea africana* Savanna in a fire treatment at Makambu, South West Africa (Geldenhuys, 1977), this decrease corresponded to 1 m tall plants of *Ochna pulchra* in the present study. The accompanying 60% reduction in plant height at Makambu was, however, not as great as the percentage reduction for the 1 m tall *Ochna pulchra*.

Although total plant mortalities may be low in both *Acacia* and *Burkea-Ochna* Savannas, it appears that in terms of canopy damage and canopy mortality the Nylsvley study species such as *Ochna pulchra* and even *Vitex rehmannii* may be less susceptible to fire than some southern African *Acacia*-dominated vegetation.

The observed high resistance of the canopy of a large individual of *Securidaca longipedunculata* to prolonged burning in the present study is in keeping with the results from the hot November burn in *Burkea africana* Savanna in South West Africa.

c) Fire and basal shoots

The present study amply confirmed an expected increase in number of basal stems per plant individual after fire. However, in contrast to some other cited findings, regeneration in terms of numbers and mass of shoots in *Terminalia sericea* after fire was far less marked and the only tree species that reacted almost as vigorously to fire as the *Terminalia sericea* in the Wankie study (Rushworth, 1975) was *Dombeya rotundifolia*. The present study's relatively great basal shoot mass in *Lannea discolor* agrees with the report for the Transvaal lowveld where after an October burn, *Lannea discolor* was one of the two species that 'sprouted well' on certain plots (Anon, 1960).

That more than half the species combinations referred to (Table 4) were significantly different with respect to mean basal shoot regeneration mass after fire appears to indicate a wide and fairly even range of values with sometimes limited variance. In the savanna plant community type studied therefore, there was no major clustering of woody plant species in terms of their basal regeneration response to fire.

Although multistemmed shrubs were (in the slower burn) somewhat more susceptible to killing of live basal shoots than were tree species, there was a clear tendency for most multistemmed shrub species, particularly non-suffrutesces, to have higher mean basal regeneration shoot mass per plant than for most tree species.

The present study data point to an almost paradoxical situation regarding fire induced basal shoot regeneration of those *Ochna pulchra* plants with 100% canopy leaf mass reduction through fire. Here a plant tends either to produce the maximum mass of basal shoots or none at all (if it dies).

The ratio of number of new basal shoots to the number of old basal shoots killed by the fire, namely the basal shoot replacement ratio, is possibly a useful attribute of vegetation that is subject to recurring fire, that is where the basal shoots that are produced after one fire are affected in a subsequent fire. It is clear that successive fires may not result in a merely additive process of increasing basal shoot numbers. If the basal shoot replacement ratio is assumed to be constant with successive fires, it may be postulated

that basal shoots of *Ochna pulchra* will increase more rapidly than those of *Burkea africana* on the basis of the existing data. A finding analogous to the present study result is the determination of a positive correlation indicating that species, for example *Burkea africana*, are dependent upon the number of parent trees for regeneration in regularly burned savanna vegetation at Makambu, South West Africa (Geldenhuys, 1977).

d) Biomass and other relations after fire

That there is a positive relation between the amount of reduction in canopy leaf mass and the amount of basal regeneration is an underlying reason for the existence (in Fig. 14) of a point corresponding to an intermediate height at which plants exhibit a maximum change in total (basal and canopy) leaf mass and below which smaller plants have a reduced loss in total leaf biomass. Although the data only support a positive change in total leaf mass after fire for smallest plants, it is likely that very large trees exhibit no significant change in total leaf biomass after fire (there is no basis for upward extrapolation of curve b in Fig. 14).

One of the main findings of the present study may be described as the difference between basal shoot mass after fire and unburnt canopy shoot mass as they depend on plant height (Figs. 15 & 17). Apart from the different forms of the relation with height and the relative proportion of the biomass components, there are also the differences in this proportion with plant height (Fig. 16). Du Toit's (1972b) relation of stem diameter (mm) and mean coppice regrowth (1×10^{-1} g) of decapitated trees of *Acacia karroo* in the eastern Cape Province

$$y = -93,85 + \frac{436,20}{25,4} x$$

indicates steadily increasingly coppice mass with increasing tree size. This pattern was not attained in the present fire study since decreased canopy damage effects in the larger trees of the burn changed this relationship in the upper size range. Only where a severe crown fire is conceivable would a Du Toit type relation be expected to apply to a burned tree population.

The present study has clearly demonstrated relationships between reduction in canopy leaf mass and basal shoot regeneration mass. But it is important to note that, although in accordance with expected effects of reduction in apical dominance, increasing damage to the canopy increased basal shoot production (up to a threshold value), there was an opposite effect for very small uncanopied *O. pulchra* plants where increased damage to the plant reduced new basal shoot production. That basal shoot production, in plants with much canopy leaf mass removed by fire, was greater in the faster burn area than in the slower burn area, suggests that the fire heat intensity also had a more direct effect on stimulation of basal shoot production possibly through more effective killing of buds in the canopy.

An indication of the possible limited resources of plants in their regeneration reaction to fire is reflected by the inverse hyperbolic distribution between number of basal shoots per plant and the mean individual basal shoot mass: a compensatory effect between number and size of basal regeneration shoots in *O. pulchra*.

It was found that in several respects, the effects of the faster fire were more variable than in the slower fire, for example, the relationship between number of basal regeneration shoots (in *O. pulchra*) and mean mass per basal shoot was tighter in the slower burn than in the faster burn. This possibly parallels the findings of Trollope (1978) in eastern Cape grassland where the rate of spread of head fires was far more variable than that of back fires. In the relationships between plant height and changes in plant size (Fig. 8), the faster fire consistently had lower correlation coefficients than those for the slower fire.

Although most different types of effects of fire on the woody plants were found to depend on plant height, a few effects were found to be independent of plant height namely: the killing of live basal shoots and the burning away of old dead basal shoots. Plant height also appeared not to affect the relationship in *O. pulchra* between number of basal regeneration shoots and the mean mass per basal shoot.

The dependency or independency of fire effects according to plant species varied from the independency of the killing of live basal shoots by fire with (tree) species to the strongest dependency with species of biomass of basal regeneration shoots per plant. The consumption by fire of old dead basal shoots and the effects of fire on dead standing plants were independent of species.

It is clear that work on specific effects of fire within the savanna woody plant and plant populations creates a basis for understanding many features of short and long term fire response systems in plants. Much further work is required before an adequate understanding of such systems in populations of woody savanna plants is obtained. An undoubted limitation of current work in this field is the neglect of the role of the below ground component of the plant in governing the above ground response to fire.

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UITTREKSEL

Uitwerking van twee intensiteite van lentebrand op verskeie aspekte van houtagtige plante van 'n Burkea africana — Ochna pulchra savanne na een groeiseisoen word gegee. Mortaliteit van houtagtige plante was baie laag, byvoorbeeld in Ochna pulchra was die mortaliteit tussen 1 en 5%. In sommige soorte waar die bogrondse dele dikwels heeltemaal weggebrand het, soos in Grewia flavescens, het geen mortaliteit van individue voorgekom nie. Daar is gevind dat basale lootmassa hergroei paraboolies afhanklik is van planthoogte terwyl die verhouding tussen blaar en takkie massa van basale loot hergroei omgekeerd verander het met plant hoogte in Ochna pulchra. Dit wil voorkom dat die vermoë van Ochna pulchra plante om nuwe basale lote te vorm nie net op plantgrootte berus nie maar ook op die aantal basale lote wat voor die brand teenwoordig was. Vir lewendige Ochna pulchra plante is daar gevind dat basale lootmassa hergroei per individu eksponensieel toeneem met groter vermindering in kroonblaar biomassa. Dié verband is ook moontlik deur direkte hitte uitwer-

kings geaffekteer. Basale lootmassa hergroei van plant soorte het baie gevarieer van 0,7 g/individu vir Dichapetalum cymosum tot 285,6 g/individu vir Euclea natalensis. Daar is 'n duidelike neiging dat nie-halfstruikvormige struiksoorte 'n groter gemiddelde basale lootmassa hergroei per plant toon as dié van meeste ander boomsoorte. Daar is 'n kompenserende uitwerking in Ochna pulchra tussen getal en grootte van basale hergroeiende lote. Staande dooie houtagtige plante (voor die brand) het of omgeval as gevolg van die vuur, of is waarskynlik nie geaffekteer deur die vuur nie. Daar is ook geen selektiwiteit op grond van plantsoort nie. Resultate van die huidige studie word algemeen gestaaf deur werk op die uitwerking van vuur in savanne en sommige ander plantegroeitipes.

REFERENCES

- AFOLAYAN, T. A., 1978. Savanna burning in Kainji Lake National Park, Nigeria. *E. Afr. Wildl. J.* 16: 245–255.
- ANON., 1960. Annual report of the biologist, Kruger National Park, 1958/1959. Review of activities. *Veld Burning. Koedoe* 3: 173–194.
- ANON., 1978. *South African programme for the SCOPE mid-term project on the ecological effects of fire*. South African National Scientific Programmes Report No. 32. 36 pp. CSIR.
- BARNES, D. L., 1965. The effects of frequency of burning and mattocking on the control of coppice in the Marandellas sandveld. *Rhod. J. Agric. Res.* 3: 55–56.
- CHRISTENSEN, M. L., 1977. Fire and soil plant nutrient relations in a pine wire grass savanna on the coastal plain of North Carolina. *Oecologia (Berl.)* 31: 27–44.
- COETZEE, B. J., VAN DER MEULEN, F., ZWANZIGER, S., GONSALVES, P. & WEISSER, P. J., 1976. A phytosociological classification of the Nylsvley Nature Reserve. *Bothalia* 12: 137–160.
- DEEMING, J. E., LANCASTER, J. W., FOSBERG, M. A., FURMAN, R. W. & SCHROEDER, M. J., 1972. *The national fire-damage rating system*. USDA Forest Service Research Paper RM-84. 165 pp. Rocky Mt Forest and Range Exp. Stn, Fort Collins, Colorado.
- DONALDSON, C. H., 1966. Control of blackthorn in the Molopo area with special reference to fire. *Proc. Grassld Soc. sth. Afr.* 1: 57–62.
- DU TOIT, P. F., 1972a. *Acacia karroo* intrusion: the effect of burning and sparing. *Proc. Grassld Soc. sth. Afr.* 7: 23–27.
- DU TOIT, P. F., 1972b. The goat in a bush-grass community. *Proc. Grassld Soc. sth. Afr.* 7: 44–50.
- FARMER, R. E., 1962. Aspen root sucker formation and apical dominance. *For. Sci.* 8: 403–410.
- GANDAR, M. V., In Press. *Description of a fire and its effects in the Nylsvley nature Reserve. A synthesis report*. South African National Scientific Programmes Report No. 00 (27 pp. typescript in Feb. 1979).
- GELDENHUYS, C. J., 1977. The effect of different regimes of annual burning on two woodland communities in Kavango. *S. Afr. For. J.* 103: 32–42.
- GILL, A. M., 1974. Toward an understanding of fire-scar formation: field observation and laboratory simulation. *For. Sci.* 20: 198–205.
- GRUNOW, J. O. & GROSSMAN, D., 1978. *Savanna Ecosystem Project, Nylsvley. Producer Group: grass layer. Summary of observations on the effect of fire on biomass accumulation rate (BAR) and biomass regime (BR) in the grass layer of Burkea Savanna over a 60 day period*. Unpublished report to the National Programme for Environmental Sciences. CSIR Pretoria. 7 pp. typescript.
- HARRINGTON, G. N., 1974. Fire effects on a Ugandan savanna grassland. *Trop. Grassld* 8: 87–101.
- HARRINGTON, G. N. & ROSS, I. C., 1974. The savanna ecology of Kidepo Valley National Park. 1. The effects of burning and browsing on the vegetation. *E. Afr. Wildl. J.* 12: 93–105.
- HARRISON, T. D., 1978. *Report on maximum temperature measurements during the Nylsvley veld fire of 5th September, 1978 and on post fire micro-meteorological measurements*. Unpublished report to the National Programme for Environmental Sciences. C.S.I.R. Pretoria. 19 pp. typescript.
- HOPKINS, B., 1963. The role of fire in promoting the sprouting of some savanna species. *J. West Afr. Sci. Assoc.* 7: 154–162.
- HOPKINS, B., 1965. Observations on savanna burning in the Olokemeji Forest Reserve, Nigeria. *J. Appl. Ecol.* 2: 367–381.
- HUNTLEY, B. J., 1978. *Nylsvley—a South African savanna ecosystem project: objectives, organization and research programme*. South African National Scientific Programmes Report No. 27. 37 pp. ISBN 0 7988 1311 3.

- HUNTLEY, B. J. & MORRIS, J. W., 1978. *Savanna ecosystem project: phase 1 summary and phase 2 progress*. South African National Scientific Programmes Report No. 29. 52 pp. ISBN 0 7988 1346 6.
- JACKSON, G., 1974. Cryptogeal germination and other seedling adaptations to the burning of vegetation in savanna regions, the origin of the pyrophytic habit. *New Phytol.* 73: 771–780.
- JAMES, T. D. W. & SMITH, D. W., 1977. Short-term effects of surface fire on the biomass and nutrient standing crop of *Populus tremuloides* in Southern Ontario. *Can. J. For. Res.* 7: 666–679.
- KAUL, R. N. & JAIN, M. B., 1967. Growth attributes—their relation to fuel yield in *Prosopis cineraria* (Linn.) McBride (*P. spicigera* Linn.) *Comm. For. Rev.* 46: 155–158.
- KEMP, R. H., 1963. Growth and regeneration of open savanna woodland in northern Nigeria. *Comm. For. Rev.* 42: 200–206.
- KENNAN, T. C. D., 1971. The effect of fire on two vegetation types of Matopos. *Proc. Ann. Tall Timbers Fire Ecology Conf.* 11: 53–98.
- LAWTON, R. M., 1978. A study of the dynamic ecology of Zambian vegetation. *J. Ecol.* 66: 175–198.
- MENAB, W. H., EDWARDS, M. B. & HOUGH, W. A., 1978. Estimating fuel weights in slash pine-palmetto stands. *For. Sci.* 24: 345–358.
- NIERING, W. A., GOODWIN, R. H. & TAYLOR, S., 1970. Prescribed burning in Southern New England: Introduction to long-range studies. *Proc. Ann. Tall Timbers Fire Ecology Conf.* 10: 267–286.
- REINERS, W. A., & WRIGHT, H. E., 1977. Impact of prehistoric and present fire patterns on the carbon dioxide content of the atmosphere. In W. Stumm, *Physical and Chemical Sciences Research Reports, 2. Global chemical cycles and their alterations by man*. Report of the Dahlem Workshop, Berlin, West Germany. November 15–19, 1976. pp. 121–135. Dahlem Konferenzen: Berlin, West Germany. ISBN 3 8200 1207 9.
- RUSHWORTH, J. E., 1975. *The floristic, physiognomic and biomass structure of Kalahari sand shrub vegetation in relation to fire and frost in Wankie National Park, Rhodesia*. M.Sc. thesis, University of Rhodesia.
- RUSHWORTH, J. E., 1978. Kalahari sand scrub—something of value. *The Rhodesia Science News* 12: 193–195.
- RUTHERFORD, M. C., 1975. *Aspects of ecosystem function in a savanna woodland in South West Africa*. Ph.D. thesis, University of Stellenbosch.
- RUTHERFORD, M. C., 1979. *Aboveground biomass subdivisions in woody species of the Savanna Ecosystem Project study area, Nylsvley*. South African National Scientific Programmes Report No. 36. 33 pp. ISBN 0 7988 1445 4.
- RUTHERFORD, M. C., In Press. Woody plant biomass distribution in *Burkea africana* savannas. In B.J. Huntley & B.H. Walker, *Ecology of tropical savannas*.
- SMITH, D. W. & JAMES, T. D., 1978. Characteristics of prescribed burns and resultant short-term environmental changes in *Populus tremuloides* woodland in Southern Ontario. *Can. J. Bot.* 56: 1782–1791.
- STRANSKY, J. J. & HALLS, L. K., 1979. Effect of a winter fire on fruit yields of woody plants. *J. Wildl. Mgmt* 43: 1007–1010.
- TINLEY, K. L., 1966. *An ecological reconnaissance of the Moremi Wildlife Reserve, Northern Okavango Swamps, Botswana*. Johannesburg: Okavango Wildlife Society.
- TRAPNELL, C. G., 1959. Ecological results of woodland burning experiments in Northern Rhodesia. *J. Ecol.* 47: 129–168.
- TRAPNELL, C. G., FRIEND, M. T., CHAMBERLAIN, G. T. & BIRCH, H. F., 1976. The effects of fire and termites on a Zambian woodland soil. *J. Ecol.* 64: 577–588.
- TROLLOPE, W. S. W., 1974. Role of fire in preventing bush encroachment in the eastern Cape. *Proc. Grassld Soc. sth. Afr.* 9: 67–72.
- TROLLOPE, W. S. W., 1978. Fire behaviour — a preliminary study. *Proc. Grassld Soc. sth. Afr.* 13: 123–128.
- TROLLOPE, W. S. W., RUTHERFORD, M. C., NOBLE, R. I., COUTINHO, L. M., MACDONALD, I. A. W., HARRISON, T. D., MENAUT, J. C., VAN WYK, P. & GROSSMAN, D., (in press). Fire as a tool in the management of savanna. In B.J. Huntley, B.H. Walker, *Ecology of tropical savannas*.
- VAN RENSBERG, H. J., 1971. Fire: its effect on grasslands, including swamps — southern, central and eastern Africa. *Proc. Ann. Tall Timbers Fire Ecology Conf.* 11: 175–199.
- VAN WYK, P., 1971. Veld burnings in the Kruger National Park. An interim report of some aspects of research. *Proc. Ann. Tall Timbers Fire Ecol. Conf.* 11: 9–31.
- WEST, O., 1965. *Fire in vegetation and its use in pasture management with special reference to tropical and subtropical Africa*. Mimeographed publication No. 1. Commonwealth Bureau of Pastures and Field Crops, Hurley, Berkshire. Commonwealth Agricultural Bureaux. 53 pp.
- WEST, O., 1971. Fire, man and wildlife as interacting factors limiting the development of climax vegetation in Rhodesia. *Proc. Ann. Tall Timbers Fire Ecology Conf.* 11: 121–145.
- ZACKRISSON, O., 1977. Influence of forest fires on the north Swedish boreal forest. *Oikos* 29: 22–32.

Monitoring *Phragmites australis* increases from 1937 to 1976 in the Siyai Lagoon (Natal, South Africa) by means of air photo interpretation

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ABSTRACT

The colonization of the Siyai Lagoon on the north coast of Natal by *Phragmites australis* was studied by means of air photo interpretation. It was possible to locate and estimate *P. australis* areas for 1957 (0,74 ha), 1965 (1,65 ha), 1969 (1,93 ha) and 1976 (2,94 ha). *Phragmites australis* first inhabited the shores of the middle section of the lagoon followed by rapid expansion in the lower section. The upper section was colonized only at its lower end by expansion from the middle section. It is suggested that *P. australis* was unsuccessful in this section because of competition by the *Hibiscus tiliaceus*—*Barringtonia racemosa* Lagoon Fringe Forest. This same community is shading out *P. australis* in some places. The notable increase in the rate of advance of land and littoral vegetation into the Siyai Lagoon was caused by sugar farming activities leading to erosion and sedimentation in the lagoon. A vegetation age gradient was observed from the upper section to the mouth region. The colonization of most of the Siyai Lagoon except the immediate mouth zone by *P. australis* Reedswamp and *Hibiscus tiliaceus*—*Barringtonia racemosa* Lagoon Fringe Forest, can be expected before the turn of the century. Dredging and mechanical control of vegetation will become necessary if major open water spaces are to be maintained.

RÉSUMÉ

CONTRÔLE DES ACCROISSEMENT DE PHRAGMITES AUSTRALIS DE 1937 À 1976 DANS LA LAGUNE SIYAI (NATAL, AFRIQUE DU SUD) AU MOYEN D'INTERPRÉTATION DE PHOTOGRAPHIES AÉRIENNES

La colonisation de la lagune de Siyai sur la côte nord du Natal par les *Phragmites australis* a été étudiée au moyen d'interprétation de la photo aérienne. Il a été possible de situer et d'estimer les régions de *P. australis* pour 1957 (0,74 ha), 1965 (1,65 ha) 1969 (1,93 ha) et 1976 (2,94 ha). *Phragmites australis* habita d'abord les rivages de la section médiane de la lagune puis s'étendit rapidement à la section en dessous. La section supérieure fut seulement colonisée dans le dessous par expansion de la section médiane. Il est considéré que *P. australis* ne réussit pas à s'étendre dans cette section par suite de la concurrence avec l'*Hibiscus tiliaceus*—*Barringtonia racemosa* Lagoon Fringe Forest. Cette même communauté supplante *P. australis* dans certains endroits. L'accroissement notable de progrès de la végétation du littoral et de l'intérieur des terres dans la lagune Siyai fut causé par les activités agricoles sucrières conduisant à l'érosion et à la sédimentation dans la lagune. A part *P. australis* aucun autre macrophyte ne fut trouvé. Une inclinaison d'âge de la végétation fut observée de la section supérieure à la région de la bouche. La colonisation de la plupart de lagune Siyai, à l'exception de la zone immédiate de la bouche, par *P. australis* Reedswamp et *Hibiscus tiliaceus*—*Barringtonia racemosa*, Lagoon Fringe Forest, doit être attendue avant la fin du siècle. Le dragage et la lutte mécanique contre la végétation deviendront nécessaires si l'on veut maintenir de grandes étendues d'eau ouvertes.

INTRODUCTION

An increase of reeds was observed on air photos when studying the dune advancement at Mtunzini (Weisser *et al.*, MS). The availability of air photo coverage for 1937–1979 offered the possibility to monitor the reed encroachment. Objectives of this work were to evaluate the adequacy of air photos in monitoring *P. australis* expansion; to provide baseline data on the Siyai Lagoon; to quantify the reed encroachment; to establish trends and extrapolate possible developments; and to offer possible management suggestions.

The Siyai drainage system is situated in Natal at latitude 28°58' South and longitude 31°45'45" East. The Lagoon is situated amidst a well-conserved, scenically beautiful, forested-dune landscape (Fig. 1). It has a surface of about 8 ha, an axial length of 2,5 km and a catchment of about 18 km² (Begg, 1978). Two streams are the main tributaries. In this work only the lagoon was studied and defined as extending from the confluence of the two tributaries to the Lagoon Mouth. Four sections were distinguished from south-west to north-east: upper section (from confluence to about 650 m north-east); middle sec-

tion (inflexion area of watercourse); lower section (to watercourse constriction) and mouth section.

Between 1937 and 1977, the mouth of the Siyai Lagoon moved about 740 m north-eastwards, at an average rate of 17,4 m/year (Weisser *et al.*, MS). The mouth is usually closed, being open for only very brief periods (of up to a week) after floods. The bar may be topped by high spring-tides and the mouth is not opened artificially (Begg, 1978).

Land encroachment into the Lagoon has increased markedly since sugar farming began in c. 1946. Changes in run-off and soil exposure caused extensive sedimentation reducing the depth to about 0,25 m in the upper zone of the Lagoon (Begg, 1978). Maximum depths of 1,5 and 2 m respectively were measured by the first author in June 1980 at the crossing of the nature trail (lower zone) and in the Lagoon mouth. Begg (pers. comm.) recorded a depth of 2,9 m in the middle section of the Lagoon.

METHODS

Information on the Siyai Lagoon and the reeds was obtained from air photos through direct inspection, enlargement and transference onto a base map using a Bausch & Lomb ZT-4 Zoom Transfer Scope (=ZTS). This instrument was also used to draw the 1:5 000 base map from the 1977 orthophoto maps

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FIG. 1.—The middle section of the Siyai Lagoon covered with *Phragmites australis* (June 1980). A photograph taken in 1964 shows only a few patches of reeds. The foreground shows leaves of *Hibiscus tiliaceus*; this plant and *Barringtonia racemosa* are the main components of the forest fringe. This community is encroaching into the *P. australis* stands.

2831 DD 21 'Mtunzini' and 2831 DC 25 'Ekukhleni'. Interpretation of the aerial photographs was aided by a Topcon Stereoscope.

The photographs used were Nos 54692 (Job 117, 1937.05.05), 9426 (Job 400, 1957.05.24), 8082 (Job 499/4, 1965.06.14), 5664 and 5609 (Job 608, 1969.08.18) and 161, 162 and 163 (Job 251, 1976.05.14). Areas were measured with an MOP-AM02 Image Analyser. Ground truth and additional field data were gathered on the 21st and 22nd of March, 21st of May and the 8th and 12th of June 1980.

The potential and limitations of the use of air photos in vegetation studies have been discussed in literature, e.g. Edwards (1972) and Weisser (1979). Concerning this study, the following points should be borne in mind. The photographs are at different scales and were not taken at the same time of year. Another factor is the differing resolution of the air photos compared, the 1937 photographs having the poorest resolution. Also, the water levels of the Siyai Lagoon varied, therefore changing the area occupied. However, the Siyai Lagoon is situated between steep dune ridges, consequently changes in water levels have only a minor influence on the area inundated. The reed growth varies seasonally. There is a time lag between the establishment of reeds and their detection on air photos. Sometimes *P. australis* colonization may be below the detection limit of the air photo taken. The density of the *P. australis* stand also varies, being at its lowest in winter. This may affect its detection on the air photos.

RESULTS AND CONCLUSIONS

Field checking confirmed that the Siyai Lagoon was a good site for studying the colonization and expansion of *P. australis* Reedswamp. The period documented in the air photos was long enough to enable the reeds to cover all the available habitat in some sections of the river, whereas in others *P. australis* is still actively expanding. The observation time was also sufficient to allow succession to proceed, and in some areas *P. australis* Reedswamp is being displaced by other riverine vegetation (Fig. 1). The results deal first with the findings on *P. australis*, then with other aquatic or semi-aquatic vegetation, and finally with the Siyai Lagoon.

Adequacy of air photos to monitor P. australis colonization

It was possible to locate and estimate *P. australis* areas for 1957, 1965, 1969 and 1976 (Table 1 & Fig. 3). The resolution of the 1937 air photos is insufficient to give conclusive evidence. Difficulties were encountered in the interpretation of Job 291 (1977) and Job 329 (1979). Their scale (1:3 000) gives too few matching points in the optical field of the ZTS.

Colonization pattern

Phragmites australis first colonized the middle and lower sections of the Lagoon. It failed to establish itself in the immediate mouth zone and in the upper region with the exception of a 0.5 m² patch in the confluence (June, 1980). Both zones are at present

TABLE 1.—Area changes (in ha) in the Siyai Lagoon (1937–1976) as shown in the air photos

Year	<i>P. australis</i> area	Open water surface	Open water without new mouth regions	Total area of lagoon
1937	0.27 (?)	5.79	5.79	6.06
1957	0.74	5.58	5.41	6.33
1965	1.65	5.17	5.00	6.82
1969	1.93	5.04	4.69	6.97
1976	2.94	4.94	3.54	7.87

FIG. 2.—The mouth section of the Siyai Lagoon showing the *Phragmites australis* stand nearest to the sea. The dunes to the right are covered with dune scrub, and the young dunes on the left are colonized by the dune pioneer *Scaevola thunbergii*.



shallow. It seems that when silting increased drastically in the upper section, the already present woody fringe vegetation rapidly invaded the new habitat and ousted *P. australis*. In the lower section of the Lagoon, *P. australis* was able to establish itself and to expand in the direction of the Lagoon mouth.

Phragmites australis Reedswamp area changes: 1937–1976

The *P. australis* surface increases at the Siyai Lagoon are summarized in Table 1 and represented graphically in Fig. 3. Whereas from 1937 to 1957 there was an increase of only 0.47 (?) ha in the area covered by *P. australis*, the area increased by 2.20 ha between 1957 and 1976. Therefore expansion of *P. australis* in the Lagoon accelerated after 1957 (Fig. 3). The curve will flatten out as the available habitat diminishes. However, with the north-eastward advancement of the mouth, new areas suitable for *P. australis* colonization are being created (Fig. 2).

Probable causes of reedswamp increase

Reedswamp expansion is often a natural process in some lagoons. Conspicuous increases of reeds have been reported in lakes after lowering of water levels (e.g. Kopf, 1964, in Weisser 1970; Björk, 1974) or when siltation increases (Weisser, 1978). Begg (1980) states that reed encroachment is due to the Lagoon becoming shallower and less saline. We agree that sedimentation and consequent reduction in depth are the chief causes of the remarkable increase in *P. australis*. No records are available for assessing the influence of the salinity factor.

The sedimentation of the Siyai Lagoon has increased strikingly, becoming critical with the advent of sugar farming in the catchment area (c. 1946 *vide* Begg, 1978). This must be considered as the main reason for the deterioration of the Siyai Lagoon. Garland (pers. comm.) considers the clearing and cultivation of Swamp Forest and *Cyperus papyrus* Swamp (c. 1955) as being especially detrimental, because of the consequent elimination of the 'sponge' function of the vegetation.

Succession

In some areas of the middle section of the Lagoon, a replacement of *P. australis* Reedswamp by the *Hibiscus tiliaceus*–*Barringtonia racemosa* Lagoon Fringe Forest was observed, probably by shading. This community seems to be the following phase in the land reclamation process in this Lagoon. This corresponds with successional schemes proposed (Edwards, 1967; see also Ward, 1980).

Reduction of open water by increase of woody shore vegetation

An expansion of the Lagoon Fringe Forest formed mainly by *Hibiscus tiliaceus* and *Barringtonia*

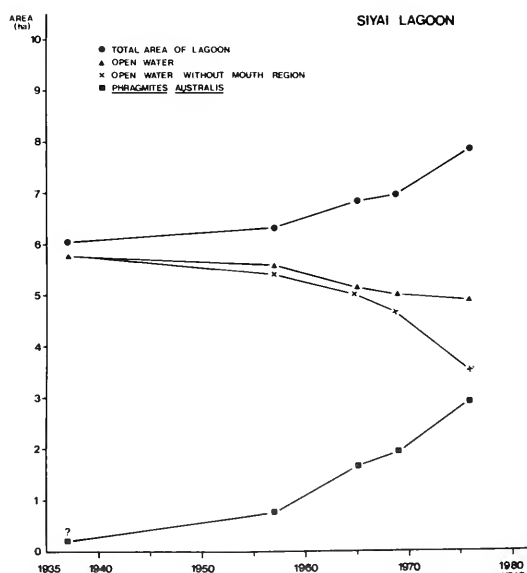


FIG. 3.—Area changes in the Siyai Lagoon 1937–1976 as shown by means of air photo interpretation.

racemosa on the upper section of the Lagoon was observed. This narrowed the Lagoon by occupying areas that were previously open water.

Age gradient of woody shore vegetation

In the upper section of the Lagoon, the woody fringe vegetation consists of dense tall trees (about 9 m), whereas the woody vegetation downstream is less dense, lower and formed by young trees. In the lower section, the woody shore vegetation is only 2 to 3 m high, discontinuous and limited to isolated seedlings of *Hibiscus tiliaceus* and *Barringtonia racemosa*. Therefore, an age gradient for the Lagoon fringe vegetation from the upper Lagoon section to the Lagoon mouth can be assumed (see also Weisser *et al.*, MS).

A few patches of dead woody fringe vegetation were noted in the lower section of the Lagoon. The preceding high water levels have been suggested as the cause by Garland (pers. comm.).

Area changes of the Siyai Lagoon

The surface covered by the Lagoon including reeds, but excluding the *Hibiscus tiliaceus*—*Barringtonia racemosa* Lagoon Fringe Forest has increased from about 6,06 ha (1937) to 7,87 ha (1976). This increase is mainly due to accretionary processes in the mouth region, which has advanced about 740 m northwards (1937–1977), therefore occupying areas previously covered by dunes (Figs 2 & 3).

The area of open water has decreased since 1937, mainly owing to the reedswamp encroachment and the expansion of the Lagoon fringe vegetation. However, the advancement of the Lagoon mouth has produced new open-water areas, compensating partially for the loss to the reed beds and the *Hibiscus tiliaceus*—*Barringtonia racemosa* Lagoon Fringe Forest. If the values are corrected by subtracting the new open-water areas of the mouth section, the real loss of open-water surface becomes evident (Table 1 & Fig. 3).

Sedimentation

The sedimentation has been heaviest in the upper zone of the Lagoon. The dense *P. australis* stand in the middle zone probably acts as a sediment trap partly protecting the lower section of the Lagoon from sedimentation.

If sedimentation is not controlled, the accelerated filling up of the bed will continue. This could eventually lead to the water breaking through and forming another bed.

Prognosis

Because of sedimentation, the colonization by *P. australis* Reedswamp and *Hibiscus tiliaceus*—*Barringtonia racemosa* Lagoon Fringe Forest of most of the Siyai Lagoon, except the immediate mouth zone, can be expected probably before the turn of the century. Any management action tending to diminish sedimentation, e.g. erosion control upstream, should be encouraged. Reeds could be controlled locally by repeated underwater cutting. The opening of a new river course may occur in the long term owing to filling up of the existing Lagoon bed. Dredging and mechanical control of vegetation will probably become necessary if major open-water spaces are to be maintained at the Siyai Lagoon.

ACKNOWLEDGEMENTS

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UITTREKSEL

Indringing deur Phragmites australis in die Siyai Strandmeer aan die Natalse noordkus is bestudeer deur middel van lugfoto-interpretasie. Dit was moontlik om Phragmites australis stande uit te wys en die oppervlakte daarvan te skat t.o.v. die jare 1957 (0,74 ha), 1965 (1,65 ha), 1969 (1,93 ha) en 1976 (2,94 ha), maar nie vir 1937 nie. Phragmites australis het eers net op die middelseksie van die strandmeer se oewers voorgekom, maar het vinnig uitgebrei na die stroom-af seksie. Die stroom-op seksie is alleenlik laer af ingedring deur uitbreiding van die middelseksie. Dit word veronderstel dat P. australis nie beter in laasgenoemde seksie kon slaag nie weens die kompetisie wat die Hibiscus tiliaceus—Barringtonia racemosa Strandmeer-oewerwoud bied. Laasgenoemde plantgemeenskap oorskadu P. australis in sommige plekke. Die merkwaardige toename in die tempo van verdringing van die Siyai Strandmeer deur slik en oewerplantegroei word veroorsaak deur suikerboerdery wat lei tot verspoeling en toeslikking. 'n Plantegroei-ouderdomsgradiënt vanaf die stroomopseksie tot by die monding is waargeneem. Indringing van die grootste gedeelte van die Siyai Strandmeer deur P. australis Rietmoeras en Hibiscus tiliaceus—Barringtonia racemosa Strandmeeroewerwoud kan voor die einde van die eeu verwag word. Indien daar noemenswaardige oopwaterruimtes in stand gehou moet word, sal baggerwerk en meganiese beheer van die plantegroei noodsaaklik wees.

REFERENCES

- BEGG, G., 1978. *The estuaries of Natal*. Natal Town and Regional Planning Report. Vol. 41.
- BEGG, G., 1980. Siyai catchment study. *Environment RSA*, 7, 3: 6–7.
- BJÖRK, S., 1974. The degradation and restoration of Lake Hornborga. In I.H.D. Nutson, *Nordic case book on inadvertent effect of man on the Hydrological Cycle*. Reprint from the Institute of Limnology, University of Lund, Lund, Sweden.
- EDWARDS, D., 1967. A plant ecological survey of the Tugela River Basin. *Mem. bot. Surv. S. Afr.* No. 36.
- EDWARDS, D., 1972. Remote sensing in the evaluation of the natural vegetation resources of South Africa. *Proc. 5th Symp. Remote Sensing, Pretoria, CSIR, May 1972*, 99–102.
- WARD, C. J., 1980. The plant ecology of the Isipingo Beach Area, Natal, South Africa. *Mem. bot. Surv. S. Afr.* No. 45.
- WEISSER, P. J., 1970. Die Vegetationsverhältnisse des Neusiedlersees. *Pflanzensoziologische und Ökologische Studien. Wiss. Arbeiten a.d. Burgenland*, 45: 1–81.
- WEISSER, P. J., 1978. A conceptual model of a siltation system in shallow lakes with littoral vegetation. *J. Limnol. Soc. sth. Afr.* 4: 145–149.
- WEISSER, P. J., 1979. Suitability of air photo interpretation for monitoring coastal dune vegetation of the Zululand Dunes, South Africa. In *The use of ecological variables in environmental monitoring*. The National Swedish Environmental Protection Board, Report PM 1151, 62–72.
- WEISSER, P. J., GARLAND, I. F. & DREWS, B. K., MS. Dune advancement 1937–1977 and preliminary vegetation succession chronology at Malazi Nature Reserve, Natal, South Africa. *Bothalia* (in preparation).

Structural and floristic classifications of Cape Mountain Fynbos on Rooiberg, southern Cape

H. C. TAYLOR* and F. VAN DER MEULEN**

ABSTRACT

Structure and floristic composition of the plant cover were used to establish separate classifications of plant communities in Mountain Fynbos on Rooiberg, South Africa. The structural units and floristic associations closely correlate with each other and their distribution reflects the major environmental influences, aspect and altitude. It is concluded that, despite the preliminary character of the survey, resource inventories of this type are suitable as a foundation for park management.

RÉSUMÉ

LES CLASSIFICATIONS STRUCTURALES ET FLORISTIQUES DES BUISSONS DE LA MONTAGNE DU CAP SUR ROOIBERG, CAP AUSTRAL

La composition structurale et floristique de la couverture de plantes ont été utilisés pour établir des classifications séparées de communautés de plantes dans le Fynbos de Montagne sur Rooiberg, en Afrique du Sud. Les unités structurales et les associations floristiques correspondent les unes avec les autres et leur distribution reflète les influences du milieu, de l'aspect et de l'altitude. Il en est conclu que, malgré le caractère préliminaire de l'étude, la ressource d'inventaires de ce type convient comme la fondation pour la conduite de parcs.

INTRODUCTION

At the request of the Department of Forestry, the first author carried out a survey of the False Macchia (Acocks, 1975) or Mountain Fynbos vegetation of the Rooiberg Mountain Catchment Area to provide basic data for a management plan (Taylor, in press). For this purpose, a simple classification, description and map were needed, dividing the vegetation into units that are visually homogeneous in physiognomy. Because these units had to be recognized by non-botanical personnel, it was decided to adopt a structural classification, rather than a floristic one. The structural survey was done by marking units of more or less uniform vegetation structure and terrain morphology on air photos (scale 1:20 000). These units were then studied in the field. In about a month's field work, sufficient information was gathered to delineate eight major structural units and 20 variations, all of which could be related to habitat. These have been mapped (1:50 000) and described in detail by Taylor (in press).

Management of Mountain Fynbos reserves such as Rooiberg aims at maximum production of clear water from catchments and the maintenance of vegetation diversity both in plant species and plant life forms. Hence, a vegetation study for management purposes should include both a floristic and a structural description. Time did not permit an extensive phytosociological survey on Rooiberg. However, to determine whether the major structural units could also be distinguished by their species composition, a brief Braun-Blanquet survey was carried out. Twenty-eight relevés were laid out subjectively within stands of vegetation that were regarded as representative of the main structural units. In the phytosociological table only vascular plants were taken into account. This paper summarizes and compares the results of the structural and floristic surveys. For in-

formation on the flora and phytogeography of Rooiberg we refer to Taylor (1979).

LOCATION AND HABITAT

About 20 km south-east of Ladismith, Cape Province (Fig. 1), lies a west-east trending mountain range, divided into more or less equal sections by the Gouritz River. The Rooiberg Mountain Catchment Area, 25 345 ha in extent, comprises a large part of the higher western section of this range at approximately 33°40'S latitude and 21°30'E longitude. It consists of State and private land, managed by the Department of Water Affairs, Forestry and Environmental Conservation for the conservation of water, flora and wild life.

The range is one of a series of isolated mountains located between Montagu and Uniondale, the fynbos of each mountain being separated from that of its neighbours by karroid lowland vegetation of the Little Karoo.

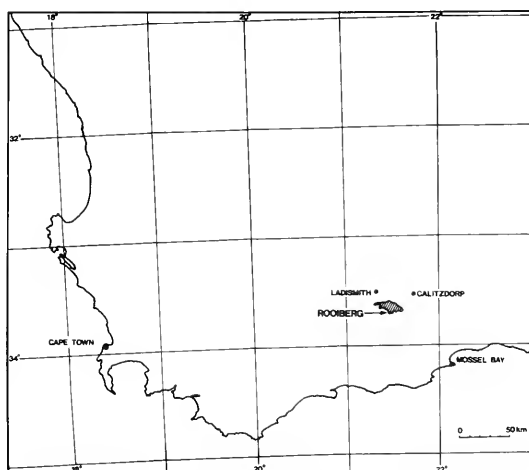


FIG. 1.—Map showing location of Rooiberg in southern Cape.

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Geomorphologically, the Rooiberg Range is a broad anticlinal fold of Table Mountain Sandstone strata, breached near the top of the arch. The breach has eroded to form a series of deeply incised kloofs that run parallel to the main crest before breaking south in deep gorges that have cut through subsidiary crests. The Table Mountain Sandstones are interrupted by a shale band that can be traced as a sinuous line across the north side of the range. Sandy lithosols cover the greater part of the reserve. Rock outcrops and cliffs are common in the interior kloofs but the main north- and south-facing sides of the range are not excessively steep.

The climate is hot and dry. Situated on the transition between the winter- and summer- rainfall areas, Rooiberg receives only the outer fringe of the winter cyclonic rains and few summer thunderstorms. The mean total precipitation for 1977/1978 (the first year after rain gauges were erected) was about 365 mm, the northern side of the mountain receiving about half as much rain as the southern slopes (P. B. Odenaal, pers. comm.). Probably the most effective precipitation is from condensation of the clouds that form around the high peaks. Considerable temperature and moisture differences may be expected between crests (about 1 400 m altitude) and footslopes of the mountain (about 800 m).

VEGETATION

1. Structural units

The vegetation units identified in the structural survey depict only gross structural characteristics. They are based on simple criteria such as estimated height and canopy cover of the vegetation and estimated proportion of (i) restioid, (ii) narrow-leaved and (iii) proteoid components. These components characterize fynbos vegetation. For convenience, their definitions are repeated here. (i) *Restioid* refers to hemicryptophytic plants of the family Restionaceae with sclerophyllous tubular stems and leaves that have been reduced to membranous, non-photosynthetic scales or small sheaths arising singly from each node. They are often tufted but sometimes rhizomatous. The category includes plants in other families that have a physiognomy similar to the Restionaceae, for example, most *Tetraria* and *Ficinia* species, some *Juncus* species and *Typha*. (ii) *Narrow-leaved* means the very narrow leptophylls, usually sclerophyllous though some may be fleshy or even succulent. It includes flat, involute and cylindrical leaves as well as revolute leaves like those of the Ericaceae. The term had to be substituted for

'ericoid' which is now restricted to revolute sclerophyllous leptophylls. (iii) *Proteoid* is the term for plants with leaves and growth form resembling proteas. They have isobilateral leaves with the shape and texture of a typical protea e.g. *Protea lorifolia*, *P. repens* or broader leaves like *P. nitida* and *P. cynaroides*. *Broad-leaved* is used here to denote the roughly ovate, sclerophyllous leathery leaves of woody shrubs derived from the northern floras as against those of typical fynbos plants (e.g. *Cassine*, *Maytenus*, *Euclea*).

The vegetation units appeared to be suitable mapping units. Where local aspect might significantly affect the vegetation and therefore the management, variations were distinguished within the major structural units. In our description the following letters have been used: N= communities on slopes of northerly aspects, S= communities on southerly aspects, C= communities of crests and K= communities of very steep kloofs. Relative positions of the communities on Rooiberg are shown in Fig. 2.

Communities with northerly aspects

Community N1. This community, comprising *Variations N1a, N1b, C1, C2*, is found on the moderately steep upper and middle slopes (1370–1060 m) to the north of the divide. The vegetation is a closed restioid and narrow-leaved shrubland in which the former element is often predominant or at least conspicuous. Variation N1a of the highlands east of Rooiberg Peak is mainly restioid and about 0.5–1 m high (Fig. 3). Most of the precipitation in this area comes from the condensation of clouds formed by the summer south-east winds. The land is privately owned and was probably burned fairly frequently in the past.

Variation C1 (Fig. 4) occurs on summits and is stunted because of its exposed site. It is sometimes dominated by grasses. Many of the localities, too small to be mapped separately, have been included in Variation C2 which occurs along the crest and major spurs at high altitude. This variation has a higher species diversity and greater variety in dominance and height of species due to many local differences in aspect and degree of slope (Fig. 5). Since the major fire belts are sited on ridges, the Variations C1 and C2, like N1a, have been subject to more frequent and regular burning than other parts of the reserve.

Variation N1b, less frequently burnt, represents vegetation of northerly aspects west of Rooiberg Peak and below Variations C1 and C2. Low narrow-

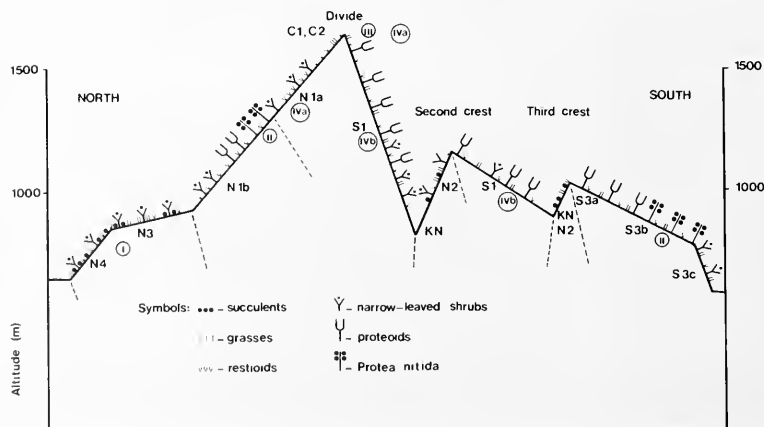


FIG. 2.—Relative positions of communities on Rooiberg.



FIG. 3.—Variation N1a above the headwaters of Groenkloof, east of Rooiberg Peak.



FIG. 4.—Variation C1 of Community N1 on the summit of Rooiberg Peak. The conspicuous grass is a *Pentaschistis* species.



FIG. 5.—Variation C2 of Community N1 on the spur running north-west from Rooiberg Peak to Taays Rand. The vegetation is restioid with *Protea eximia* in the right foreground. In and beyond the shadow is a patch of dense proteoid shrubland on a local southerly slope.

leaved shrubs prevail, but at middle altitudes the proteoid element (*Protea repens*, *P. eximia*, *P. lorifolia*) increases in height (up to 2 m) and cover (up to 75%) (Fig. 6). *Leucadendron salignum* extends in a broad belt across the middle slopes, giving them a yellow-green speckled appearance. At the middle altitudinal limit of this variation is a similar belt of the grey-leaved small tree, *Protea nitida* (Waboom) which, though less widespread than *Leucadendron salignum*, often overlaps its range. This 'Waboomveld' is recognizable on air photos but is too restricted in area to map separately.

Community N2. Including *Variations NE and NW*, this community occurs between about 1 300 and 650 m on steep northerly slopes beneath the second crest (Fig. 7). These lower slopes receive less cloud moisture and are therefore warmer and drier than those of Variation N1a, north of the divide. Narrow-leaved shrubs exceed restioids in cover while proteoids are rare and of a more xeromorphic type, like *Protea lorifolia*. The community contains a fair

number of succulents and grasses although their cover is not high. Sites with north-east and north-west aspects are separated as Variations NE and NW respectively. The narrow-leaved shrub *Passerina vulgaris* tends to dominate on both aspects and *Protea punctata* occurs locally on upper slopes in variation NE.

Community N3. This community is found between 1 060 and 900 m on the plateau or shelf on the northern side of the mountain below Variation N1b. Slopes are gentle to almost level and very stony. The vegetation, about one metre in height, is characterized by the predominance of narrow-leaved shrubs in the upper canopy (Fig. 8). In lower layers, restioids, grasses and succulents (mainly Mesembryanthemaceae) can be quite numerous.

At the western limit of the range or at the outer edge of the plateau where less rain falls, elements of Renosterveld, especially the Renosterbos (*Elytropapus rhinocerotis*), become conspicuous.



FIG. 6.—Variation N1b where the proteoid cover reaches up to 75%: *Protea lorifolia* in the foreground, *P. eximia* behind, c. 1–2 m.



FIG. 7.—The second crest showing Community N2 between the skyline and the steep cliffs. Variation NE the darker patch at top left, and Community KN on the precipitous lower slopes.



FIG. 8.—At Nicolaaskloof, typical Community N3 is confined to the sloping shelf in the foreground. On the rocky slopes beyond, N3 intergrades with proteoid N1b above the figure's head.



FIG. 9.—Community N4 on the steep north-facing basal slope.

Community N4. This community occurs on steep north-facing slopes between 900 and 700 m, below Community N3 down to the base of the mountain. The soils are very stony, shallow and dry. Like the previous one, Community N4 is dominated by narrow-leaved shrubs (Fig. 9) but the vegetation is more open and poorer in species content, containing some karroid elements and more succulents than usual in fynbos because this community borders on the karroid vegetation of the lowlands.

Community KN (including *Community K*). The main drainage of upper Rooiberg comprises four complex kloof systems that occupy the rift south of the divide. In their upper reaches the kloofs run parallel to the divide and then drain south. The north side of the range is drained by five large kloofs running east or north-east and a series of shorter, shallower kloofs running north. Community KN is found at lower levels of all the southward draining kloofs.

The habitat is a very steep to precipitous rock slope with some soil accumulated in pockets and bands between the vertical cliffs (Figs 7 & 10). The kloofs draining north or north-east have no distinct north or south aspects, but the vegetation of their steep sides, Community K, appears structurally similar to that of Community KN. In both communities the canopy cover is low (about 25–70%) and consists of scattered shrubs with a rounded growth form 1–2 m in diameter, interspersed with coarse restioids and grasses, some broad-leaved bushes of tropical affinity (e.g. *Diospyros dichrophylla* and *Cussonia spicata*) and succulents in the ground layer. Proteoids are usually absent. The vegetation, like the habitat, is very similar to N4.

Communities with southerly aspects

Community S1. This community, which includes *Variations SW* and *SE*, is found on moderately steep

to very steep southerly slopes from 1 490 m down to about 630 m. The well drained, shallow soil consists of fine grey humic sand with some leaf litter. At high elevations, these slopes receive moisture condensed from the clouds that form in the south-east wind, therefore reducing the effect of the hot, dry summers. The vegetation is dense shrubland with a closed, uniform canopy of proteoids up to 2 m high. There is at least one lower layer of restioids and narrow-leaved shrubs similar in structure to the canopy of Community N1a.

Within Community S1 there are several structural variations, possibly resulting from differing proteoid dominance: at the highest, steepest sites, *Protea punctata* occurs in almost pure stands with some *Leucadendron comosum* (Fig. 11); at middle altitudes *Leucadendron eucalyptifolium* becomes either dominant or co-dominant with *Protea punctata*. At still lower elevations, the number of proteoid species increases with the addition of *Protea eximia* and *P. neriifolia* but their total cover decreases until

at the lowest parts the proteoid layer contributes about 50% canopy cover and is only about 1 m high, while the restioid and narrow-leaved layer becomes closed. Since these structural variations either form mosaics or intergrade with each other, they cannot be mapped separately at the 1: 50 000 scale. Variations SW and SE, with western and eastern aspects respectively, are mappable units of the open proteoid community of lower altitudes down to about 400 m, which include *Protea repens*, *P. lorifolia* and *Leucadendron salignum*. Grasses are also more frequent in these variations than in the other variations of Community S1.

Community S2. This community was found only in a small area on the steep upper south-easterly slopes of the peak marked by Trigonometrical Survey beacon No. 149. Stands on similar sites on the highest peaks, which possibly belong to the same community, have been affected by a fire belt. Shallow, black, humic soil, more moist than other Rooiberg soils, occurs between the bands of outcrop-



FIG. 10.—North-facing krans on the left with vestiges of Community KN at its base. Gorge of the south-flowing Bos-rivier.



FIG. 11.—Tall dense proteoid shrubland of Community S1 dominated by *Protea punctata* with a fringe of *P. eximia* in front, bordering on a fire-belt in the foreground where restioids and narrow-leaved shrubs of the lower layer are prominent.

TABLE 1.—Floristic classification of communities on Rooiberg (compare with Fig. 2)

x = occurring in close vicinity of relevé
 Leaf forms: P = broad-leaved sclerophylls; N = narrow-leaved leptophylls; (N) = slightly broader than N; G = graminoid;
 P = proteoid; R = restioid (Restionaceae); (R) = restioid (other families); S = succulent; O = other forms.
 See text for definitions.

Community number		I	II	III	IVa	IVb
Altitude (m)						
	8 8 8 9 8 7 6 9 8	5 6 8 0 6 5	1 1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1
	5 2 0 1 5 7 4 6 3	6 2 8 8 4 0	4 4 3 2 2	4 3 4 3	3 3 4 3	3 3 4 3
	3 3 0 4 3 7 0 0 8	4 5 4 2 0 3	6 9 1 5 9	1 7 1 1	8 4 0 2	5 1 2 6
Structural units	NNNNNNNN	SSNNSS	CCCCC	NNCC	SSSS	SSSS
	4 4 4 3 3 3 3 3	3 3 3 1 3 3	1 1 1 2 2	1 1 2 1	1 1 1 1	1 1 1 1
Total number of species	1 1 3 2 2 2 2 5 4	7 5 5 4 4 3	3 3 3 3 3	3 4 4 3	4 4 2 3	4 4 2 3
	7 4 5 9 1 9 3 3 0	4 0 1 5 9 9	2 9 0 4 8	2 5 3 8	8 5 7 6	8 5 7 6
Relevé number	4 4 4 4 4 4 4 4 4	4 4 4 4 4 4	4 4 2 4 4	4 4 4 4	4 4 4 4	4 4 4 4
	7 8 3 7 8 8 2 2	4 4 3 4 7 4	7 3 2 3 3	3 3 0 7	3 4 3 3	3 4 3 3
	5 5 3 3 6 8 7 9 8	7 4 7 2 1 8	4 0 2 6 9	4 2 5 2	5 1 1 8	5 1 1 8
Differential species for community of northern lower slopes						
N Felicia filifolia	1 1 + + + + + + +					
S Zygophyllum sp. (rel. 487)	+ + + + + + +					
N Euryops erectus	1 + + + x + +	+				
(N) Aspalathus granulata	+ + + + 1 + +					
G Ehrharta squarrosa	x + + x + +					
S Mesem. sp. (No. 123)	x + +					
Differential species for community of middle slopes						
P Protea nitida		2 1 2 1 1				
O Mohria caffrorum		+ 1 + + 2				
(R) Ficinia deusta		+ + + + +				
(N) Eroeda imbricata		+ + x + 1 +				
(N) Pelargonium myrrhifolium		+ + + + +	+			
N Elytropappus glandulosus		1 2 1 2 +				
G Themeda triandra		+ 1 1 2				
N Sutura stenophylla		+ + + + +				
P Leucadendron salignum		1 2 1				
S Carpobrotus sp. (rel. 448)	x	+ + + + +		1		+
O Chamaraea capensis		x x x +				
B Euclea polyandra		x x +				
O Aristeia pusilla		x x +				
Differential species for communities of lower and middle slopes						
N Eriocephalus umbellulatus		2 1 +				
N Aspalathus sceprum-aureum		x x +				
O Hermannia odorata		x x +				
O Lobelia spartioides		x x +				
N Phylica rigidifolia		+ + +				
R Restio gaudichaudianus		+ 2 +				
G Merxmüllera arundinacea	2 1	3 +				
N Elytropappus rhinocerotis	2 1	1 +				
N Aspalathus hirta		2				
Differential species for community of summits and crest						
N Selago brevifolia			+			
N Rutaceae (Taylor 9210)			+			
N Helichrysium ericoides			+			
O Gazania linearis			+			
S Crassula sp., cf. cephalophora			+			
O Pelargonium tricolor			+			
Differential species for communities of lower and middle slopes and crest						
G Pentaschistis eriostoma	+ +	1 1 1 +	2 3 1	+	+	
N Anthospermum aethiopicum	1	+ 1				
(R) Ficinia nigrescens	+ + + + +	+ +				
R Restio cuspidatus	x	1 1 1 +	1 1 + x			
Differential species for community of southern upper slopes						
P Protea punctata						
P Leucadendron comosum						
P Leucadendron eucalpytifolium						
R Elegia juncea						
N Erica calycina						
N Erica sp., cf. quadrangularis						
Differential species for community of upper slopes						
(R) Tetraria ustulata						
(R) Tetraria involucreta						
O Nivenia capitata						
P Protea lorifolia						
P Protea eximia						
N Erica cerinthoides						
N Erica hispidula						
N Spatalla confusa						
R Cannamois virgata						
(R) Tetraria sp., cf. cuspidata						
Differential species for communities of crest and upper slopes						
N Aspalathus rubens						
R Hypolaena purpurea						
N Metalasia gnaphaloides						
(N) Struthiola martiana						
(N) Agathosma ovalifolia						
P Protea repens						
R Elegia galpinii						
(R) Ficinia zeyheri						
N Clifforia ruscifolia						
N Clifforia tuberculata						
N Ursinia sericea						
N Lobelia coronopifolia						
(R) Tetraria exilis						
N Thoracosperma galpinii						
(R) Ficinia ixioides						
R Restio hystrix						
Companions						
R Restio fruticosus						
N Passerina vulgaris						
N Lightfootia rigida						
N Helichrysium paniculatum						
R Thamnochortus argenteus						
R Hypodiscus striatus						
N Centella virgata						
N Anthospermum ciliare						
N Clifforia crenata						
G Ehrharta ramosa						
(R) Ficinia filiformis						
N Phylica purpurea						
O Crassula lycopodioides						
R Restio triticeus						
And the following number of species occurring in less than 8 relevés	0 0 2 1 0 1 0 3 2	4 2 3 2 2 1	1 2 1 1 1	1 2 2 1	2 2 1 1	
	8 7 2 3 6 2 8 4 3	3 5 0 3 7 4	2 3 3 2 5	1 5 4 6	3 3 6 6	

to very steep southerly slopes from 1 490 m down to about 630 m. The well drained, shallow soil consists of fine grey humic sand with some leaf litter. At high elevations, these slopes receive moisture condensed from the clouds that form in the south-east wind, therefore reducing the effect of the hot, dry summers. The vegetation is dense shrubland with a closed, uniform canopy of proteoids up to 2 m high. There is at least one lower layer of restioids and narrow-leaved shrubs similar in structure to the

at the lowest parts the proteoid layer contributes about 50% canopy cover and is only about 1 m high, while the restioid and narrow-leaved layer becomes closed. Since these structural variations either form mosaics or intergrade with each other, they cannot be mapped separately at the 1: 50 000 scale. *Variations SW and SE*, with western and eastern aspects respectively, are mappable units of the open proteoid community of lower altitudes.



front, bordering on a fire-belt in the foreground where restioids and narrow-leaved shrubs of the lower layer are prominent.

FIG. 12.—The dense, narrow-leaved shrubland Community S2 on a cool, moist slope.



FIG. 13.—Scattered Waboom (*Protea nitida*) barely discernible in the narrow-leaved matrix of Community S3 on the middle slopes above Buffelsfontein.



ping bedrock. The vegetation is a dense, narrow-leaved shrubland up to 1,5 m tall in which species indicating moist conditions, like *Berzelia intermedia* and *Psoralea pinnata*, are prominent (Fig. 12). Near the lower limit some tall proteoid and restioid components (*Protea punctata* and *Cannamois virgata*) occur.

Community S3. This community has a wide distribution from the third crest of the range down to the foot of the mountain and along its entire length. The gentle to moderate southerly slopes have dry, sandy lithosols. In the west, the slope becomes steep, with bands of kranses (cliffs) interspersed with colluvial boulders. The vegetation varies in height and cover but is generally less dense than that of Communities S1 and S2. Floristically and structurally, Community S3 is probably the most diverse of all the Rooiberg vegetation types. *Leucadendron salignum*, the only constant feature, occurs virtually everywhere. *Community S3a* of the upper slopes between 915 and about 760 m has a fairly dense mixed proteoid vegetation with the highest concentration of proteoid

species in the reserve; the understorey is chiefly restioid. A belt of Waboomveld, with *Protea nitida* conspicuous, extends along the middle slopes from about 760 m to 640 m (*Community S3b*); narrow-leaved shrubs predominate and grasses are fairly frequent (Fig. 13). Along the lowest slopes, especially to the west, is a zone of karroid narrow-leaved shrubs (e.g. *Pteronia*, *Relhania*) about 1,5 m high constituting up to 75% canopy cover, in which the coarse tufted grass *Merxmüllera arundinacea* is often conspicuous (*Community S3c*.)

2. Floristic units

We have sampled the vegetation by means of Braun-Blanquet relevés (Table 1) varying in size from the usual 50 m² to about 100 m², 200 m² or 300 m² depending on differing vegetation structure. Some units, like S1, are undersampled, the rare ones like S2, KN & N2 are not sampled at all, while others have been sampled more intensively because of their special interest, e.g. the *Protea nitida*-dominated Waboomveld which occurs in different floristic subdivisions throughout the range of Mountain Fynbos.

TABLE 2.—Comparison of structural and floristic units

Structural unit (and variations)	Floristic unit	Main habitat characteristics	Predominant species
N1 (incl. N1a, N1b, C1, C2) Closed restioid and narrow-leaved shrubland up to 1 m (N1a, C1, C2), with proteoid (2 m) dominance at middle altitudes (N1b) and graminoid dominance on summits (C1)	III, IVa (II)	Highlands and crests (N1a, C1, C2); moderately steep upper and middle northern slopes (N1b)	<i>Restio fruticosus</i> , <i>R. cuspidatus</i> , <i>Thamnochortus argenteus</i> , <i>Hypodiscus purpureus</i> , <i>Tetraria ustulata</i> , <i>Centella virgata</i> , <i>Lightfootia rigida</i> , <i>Aspalathus rubens</i> , <i>Pentastichis eriostoma</i> , <i>P. colorata</i> , <i>Ehrharta ramosa</i> .
N2 Fairly open to dense narrow-leaved and restioid shrubland up to 1,5 m with grasses and succulents.	Not sampled	Steep northern slopes beneath the second crest	<i>Passerina vulgaris</i> , <i>Elytropappus glandulosus</i> , <i>Muraltia</i> spp., <i>Restio</i> spp.
N3 Fairly dense narrow-leaved and restioid shrubland up to 1 m with grasses and succulents	1	Gentle to almost level lower northern slopes	<i>Felicia filifolia</i> , <i>Anthospermum aethiopicum</i> , <i>Passerina vulgaris</i> , <i>Elytropappus rhinocerotis</i> (loc.), <i>Euryops erectus</i> , <i>Relbania squarrosa</i> , <i>Phylica rigidifolia</i> , <i>Restio fruticosus</i> , <i>Hypodiscus striatus</i> , <i>Thamnochortus argenteus</i> , <i>Pentastichis eriostoma</i> , <i>Merxmuellera arundinacea</i> , <i>Mesems</i> , <i>Crassula</i> spp.
N4 Fairly open narrow-leaved shrubland up to 1 m with succulents and karroid elements	1	Steep lower northern slopes beneath community N3	
KN (incl. K) Open narrow-leaved and broad-leaved shrubland up to 1,75 m with coarse restioids, grasses and succulents	Not sampled	Very steep rock slopes of kloofs	<i>Metalasia pallida</i> , <i>Phylica purpurea</i> , <i>Cullumia bisulca</i> , <i>Diospyros dichrophylla</i> , <i>Restio fruticosus</i> , <i>Merxmuellera arundinacea</i> , <i>Crassula</i> spp.
S1 (incl. SW, SE) Dense proteoid shrubland up to 2 m with lower restioids and narrow-leaved shrubs	IVb	Moderate to very steep upper southern slopes	<i>Protea punctata</i> , <i>Leucadendron comosum</i> , <i>L. eucalyptifolium</i> , <i>Erica hispida</i> , <i>E. calycina</i> , <i>Elegia juncea</i> , <i>Tetraria ustulata</i>
S2 Dense narrow-leaved shrubland up to 1,5 m	Not sampled	Steep upper southern slopes (limited area)	<i>Berzelia intermedia</i> , <i>Psoralea pinnata</i> , <i>Cannamois virgata</i>
S3 (incl. S3a, b, c) Fairly dense mixed proteoid shrubland up to 1,5 m (S3a); narrow-leaved shrubland (1 m) with <i>Protea nitida</i> conspicuous and emergent to 2,5 m (S3b); fairly open narrow-leaved karroid shrubland to 2 m (S3c)	II (= S3b) S3a, c not sampled	Gentle to moderate lower southern slopes: upper (S3a), middle (S3b) and lower (S3c) zones; one relevé on north side of mountain	<i>Protea repens</i> , <i>P. neriifolia</i> (S3a); <i>Protea nitida</i> , <i>Leucadendron salignum</i> (S3b), <i>Anthospermum ciliare</i> , <i>Elytropappus glandulosus</i> , <i>Lightfootia rigida</i> , <i>Aspalathus scepterum-aureum</i> , <i>Sutera stenophylla</i> , <i>Eroeda imbricata</i> , <i>Restio cuspidatus</i> , <i>Ficinia deusta</i> , <i>Pentastichis eriostoma</i> , <i>Cymbopogon marginatus</i> ; <i>Themeda triandra</i> (S3b)

COMPARISON OF STRUCTURAL AND FLORISTIC UNITS

A comparison of the structural and floristic units is summarized in Fig. 2 & Table 2.

Community I. Of the lower northern slopes this community comprises all relevés in structural units N3 and N4. Predominant growth forms include restioids (*Restio fruticosus*, *Thamnochortus argenteus*, *Hypodiscus striatus*) and narrow-leaved shrubs (*Felicia filifolia*, *Passerina vulgaris*). The first three relevés of this community are located in structural unit N4 which, it was noted, is poorer in species than N3. In fact, Relevés 475 and 485 have the lowest species content of any in the survey.

Community II. This 'Waboomveld' community represents stands of middle and lower slopes mainly with southerly aspects (structural unit S3b) characterized not only by *Protea nitida* but also by *Mohria caffrorum* and *Pelargonium myrrhifolium*, species that are frequent in Waboomveld over a wide geographical range. Predominant life forms include proteoids (*Protea nitida*, *Leucadendron salignum*), narrow-leaved shrubs (*Elytropappus glandulosus*, *Anthospermum ciliare*), restioids (*Restio cuspidatus*, *R. fruticosus*) and grasses (*Pentastichis eriostoma*, *Themeda triandra*). At the footslopes of the mountain, below the Waboomveld, karroid elements (e.g. *Pteronia* and *Relbania* spp.) are found.

Relevé 448 has no *Protea nitida* and few other differential species. It would seem that within Community II the species-rich Waboom stands are, in special situations, part of a wider-ranging vegetation

type that lacks *Protea nitida* and is in general less rich in species content. This hypothesis might have important management implications and can only be tested by more sampling. Relevé 442 is the only one in Waboomveld on the northern side of the mountain. It occurs at a considerably higher altitude than any of the relevés on the south side. Almost two decades ago Taylor (1963) observed that *Protea nitida* 'does seem to occur at higher altitudes on the northern slopes', probably to compensate for the hotter and drier conditions found there.

Community III. This community comprises relevés situated on summits and the crest fire-belt (structural units C1 & C2), burnt just less than four years before the survey. Predominant life forms include narrow-leaved shrubs (*Centella virgata*, *Aspalathus rubens*, *Selago brevifolia*) and restioids (*Restio cuspidatus*, *R. fruticosus*). The three summit relevés, Relevés 474, 430 and 222 all show high scores for the grass *Pentastichis eriostoma*; *Ehrharta ramosa* and *Pentastichis colorata* also occur in the community. Relevé 439 is particularly poor in differential species. It may represent a related but undersampled community. Within Community III, this relevé is the only one not situated on the main crest and that has vegetation over 1 m in height, suggesting that it may lie outside the four-year old firebelt.

Community IV. This community comprises two subcommunities, a and b, mainly distinguished from each other by the presence in IVb of an overstorey of proteoids (*Protea punctata*, *Leucadendron* spp.) and

the fact that IVa has no differential species. Subcommunity IVb occurs on upper southern slopes bearing the proteoid structural unit S1. In Subcommunity IVa two relevés (432, 434) are on upper north-facing slopes bearing the restioid structural unit N1a; one (405) is on a spur (C2) and one (472) is on a summit (C1). Therefore three structural units appear to be combined in one floristic group. On the other hand, one structural unit (C1) has three relevés (474, 430 & 222) in floristic Community III and one (472) in IVa. The data are insufficient to determine whether these anomalies are due to fire-age or other habitat factors. They may merely show that structural units N1a, C1 and C2 are not distinct entities.

Table 1 indicates that stands of lower and middle slopes, bearing the structural units N3, N4 and S3 (floristic Communities I, I and II respectively) are floristically more related to each other than to any of the other stands. The same appears to apply to stands of crests and upper slopes bearing the structural units N1 and S1 (floristic Communities III + IVa and IVb respectively).

The results from the structural and floristic surveys indicate that structure and species composition of the vegetation are related to major habitat factors like altitude and aspect.

CONCLUDING REMARKS

Both in the structural and the floristic surveys, we have sampled only the major matrix of fynbos communities and not the detailed patterns. Our results are therefore provisional.

The floristic survey, even a brief one like that on Rooiberg, supported and supplemented the structural survey. The latter can be done without extensive *a priori* knowledge of the complex fynbos flora, and has the advantage of being quicker and the data can be used by personnel with little botanical training. Emphasis is not on the plant species but rather on its functional adaptation to the environment. The structurally homogeneous units will be characterized by particular life and growth forms and can be expected to react in a reasonably uniform way to treatment such as burning, and to use such as grazing by game. The structural classification will therefore help managers to delineate management units, to determine rotation lengths and stocking rates, to maintain balanced, natural ecosystems and to monitor physiognomic changes.

In the floristic survey, emphasis is on species composition of the plant cover, and the ecological amplitudes of plant species are used to describe plant communities and their interrelationships. The floristic classification will indicate which species and communities are threatened, and will provide information on how to conserve them and how to maintain species diversity.

In conclusion, we think that a combination of a structural and floristic survey, as we have described, is a necessary and suitable basis for fynbos conservation management.

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UITTREKSEL

Die struktuur en floristiese samestelling van die plantegroei is gebruik vir die daarstelling van afsonderlike klassifikasies van plantgemeenskappe in Bergfynbos op Rooiberg, Suid-Afrika. Die strukturele eenhede en floristiese assosiasies is sterk met mekaar gekorreleer en hulle verspreiding weerspieël die vernaamste omgewingsfaktore, nl. aspek en hoogte bo seespieël. Ten spyte van die voorlopige aard van die opname, is die gevolgtrekking dat hulpbronopnames van hierdie aard 'n geskikte grondslag vorm vir die bestuur van natuurlike gebiede.

REFERENCES

- ACOCKS, J. P. H., 1975. Veld types of South Africa. 2nd edn. *Mem. bot. Surv. S. Afr.* No. 40. 128 pp.
- TAYLOR, H. C., 1963. A bird's-eye view of Cape mountain vegetation. *J. bot. Soc. S. Afr.* 49: 17-19.
- TAYLOR, H. C., 1979. Observations on the flora and phytogeography of Rooiberg, a dry fynbos mountain in the southern Cape Province, South Africa. *Phytocoenologia* 6: 524-531.
- TAYLOR, H. C., in press. *A reconnaissance of the vegetation of Rooiberg State Forest*. Department of Forestry, Technical Bulletin.

Miscellaneous ecological notes

VARIOUS AUTHORS

INVESTIGATION INTO THE SIGNIFICANCE OF PLANT DISPERSION IN ASSESSING PASTURE CONDITION

The description of pasture condition in terms of percent cover and species composition is undesirable as these measures are not the sole criteria. It has been found, for example, at the Rietvlei Agricultural Research Station, near Pretoria, that heavily fertilized mown veld has a lower basal cover than unfertilized grazed veld, yet produces more than three times the amount of herbage than the unfertilized veld. The ultimate aim of pasture management is the maintenance of a healthy sward and it is possible that the measurement of the uniformity of plant cover may be of value in establishing an objective concept of pasture condition. It is intended, in this Note, to discuss various aspects of plant dispersion and their use in interpreting certain phenomena. In this paper the nature of the non-randomness is termed 'overdispersed' or 'contagious' when individuals tend to be clumped together and 'underdispersed' or 'regular' when individuals are evenly scattered. It is stressed that the terms overdispersed and underdispersed refer to the distribution curves of data and not to the pattern of plant individuals on the ground.

For the purpose of this investigation the Bruce Levy point quadrat (Levy & Madden, 1933) was used. Three bridges were made with 20 points each spaced at 1 cm, 2 cm and 5 cm intervals. The bridges, referred to in this paper as quadrats, were laid either 100 or 200 times at random in each experimental plot, all of which were smaller than one hectare. A 't' test showed that sufficient samples had been taken to ensure an accuracy of 10 percent of the mean number of strikes per bridge at $p=0.05$. In one analysis a bridge with 30 points at 5 cm intervals was used.

Random distributions may be described by the Binomial distribution, or by the Normal and Poisson approximations to that distribution. When the frequency curves of plants occurring in quadrats are compared with any one of these curves (depending on the nature of the sample), it is noticed that there is often a considerable discrepancy between the observed and calculated values. Clapham (1936) and Blackman (1942) compared frequency distributions of species occurring in quadrats with the Poisson distribution and they found that many of the species were not randomly dispersed. They expressed this deviation from the expected distribution by comparing the observed variance of the samples with the expected variance. Neyman (1939) and Thomas (1949) expressed the principle of contagious distribution in generalized forms of the Poisson distribution. The various frequency distributions are described below.

The Binomial distribution

The frequencies of 0, 1, 2, ... successes (strikes) in N sets are given in terms of the binomial expansion of $N(p+q)^n$ where N is the number of quadrats, p the probability of an event occurring, q the probability of the event not occurring and n the number of trials (points per quadrat). An easy method of calculating the successive terms in a binomial expansion is by using the relationship:—

$$\begin{aligned} \log (\text{probability of } x \text{ plants} \\ \text{occurring in any 1 quadrat}) &= \log n! - \log \\ &= \log n! - \log x! \\ &+ (n-x) \log q \\ &+ x \log p. \end{aligned}$$

In the Binomial distribution the mean is np and the variance npq .

The Poisson distribution

This distribution is given by the series

$$\text{probability of } x \text{ plants} \quad = \frac{m^x e^{-m}}{x!}$$

$$\text{occurring in any 1 quadrat}$$

where m is the mean number of plants per quadrat. In the Poisson distribution the mean is equal to the variance. When m is very small the distribution is an approximation to a Binomial distribution.

The Neyman contagion

This distribution is a generalization of the Poisson distribution and is given by:

$$p(x=0) = e^{-m_1(1-e^{-m_2})} \text{ and subsequent terms by}$$

$$p(x=k+1) = \frac{m_1 m_2 e^{-m_2}}{k+1} \sum_{t=0}^k \frac{m_2^t}{t!} p(x=k-t)$$

where the parameters m_1 and m_2 are proportional to the mean number of groups per quadrat and mean number of individuals per group respectively (Neyman, 1939). The parameters can be estimated from the first and second moments of the distribution as

$$m_2 = (\mu_2 - \mu_1)/\mu_1 \text{ and } m_1 = \mu_1/m_2$$

When m_2 becomes very small and $m_1 m_2$ is finite the distribution approaches the Poisson where $\mu_2/\mu_1 = 1$.

The Thomas distribution

This distribution is given by

$$\begin{aligned} p(k=0) &= e^{-m} \text{ and subsequent terms by} \\ p(k) &= \sum_{r=1}^k \frac{m^r e^{-m}}{r!} \frac{(r\lambda)^{k-r} e^{-r\lambda}}{(k-r)!} \end{aligned}$$

The parameters m and $1+\lambda$ are the mean number of groups per quadrat and mean number of individuals per group respectively and are obtained from the first and second moments of the distribution where

$$\mu_1 = m(1+\lambda) \text{ and } \mu_2 = m(1+3\lambda+\lambda^2)$$

As λ becomes very small the distribution approaches the Poisson (Thomas, 1949).

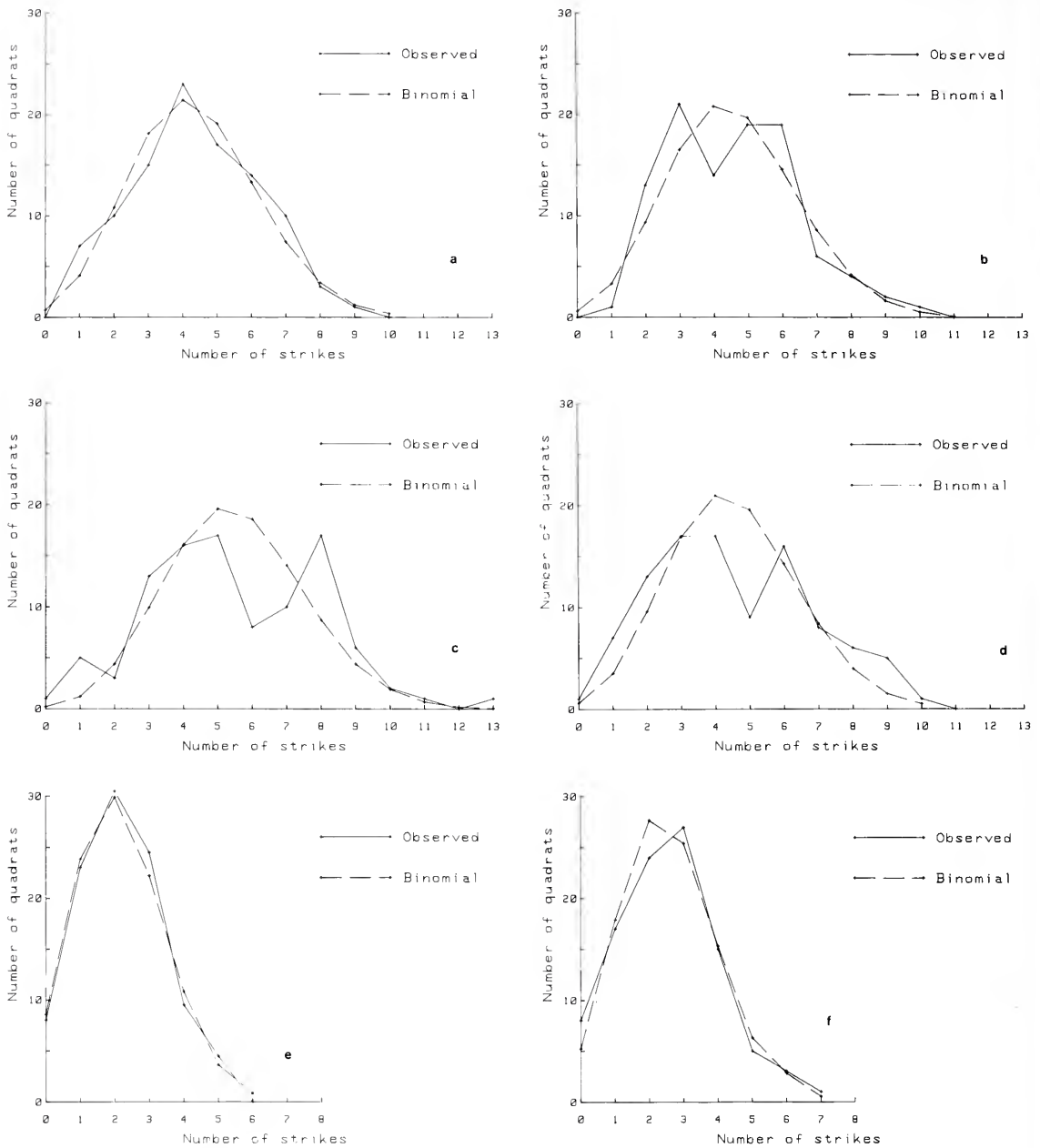


FIG. 1.—Frequency distributions of all plants compared with the expected Binomial distribution in a, plot 1; b, plot 2; c, plot 3; and d, plot 4 with 20 points per quadrat at 5 cm espacement and 100 quadrats; e, plot 1; and f, plot 3 with 10 points per quadrat at 10 cm espacement and 100 quadrats.

The frequency distribution of all plants occurring in plot 1 is given in Fig. 1a. The general appearance of the veld is that it is uniform and in excellent condition. The hay cuts from this heavily fertilized plot are more than three times those from unfertilized veld. The veld initially was a *Themeda triandra*, *Hyparrhenia hirta*, *Trachypogon spicatus* type but, as a result of the treatment, changed to *Setaria nigrirostris*, *S. perennis* and *Eragrostis chloromelas*, with relics of *Themeda triandra* and *Hyparrhenia hirta*. An examination of the figure will show that the fit of the observed values to the expected Binomial curve is very close ($P\chi^2 = 0.8-0.9$). The V/npq ratio

(1,0104) is almost unity, signifying that the observed and expected parameters show close agreement. In plot 2, in which the treatment is the same as for plot 1, except that it is limed, the distribution also does not differ significantly from the expected values (Fig. 1b) although the fit is not quite as good. The V/npq ratio is 0.9985. Plots 3 and 4 were recently fertilized and grazed and from Figs 1c and 1d it is seen that the distributions of observed data points are distinctly bimodal and differ significantly from the expected Binomial distributions. From veld observations it was evident that vegetation changes were occurring in these plots. The initial effect of the fertilizer is that

certain climax species are driven out and are replaced by others lower in the succession, and it is during this period that the productivity and vigour of certain species is profoundly affected. The bimodality of the distributions indicates that one is sampling a heterogeneous population, consisting of areas of low cover and others of high cover. The Neyman and Thomas distributions are built on premises that (a) the individuals in a cluster are randomly dispersed and (b) the clusters in a population are randomly dispersed. Because of the close agreement between the observed and expected values obtained by Archibald (1948, 1950), Barnes & Stanbury (1951) and in this paper, it may be accepted that these premises are valid. The bimodal curves, which cannot be adequately described by the Neyman and Thomas series, may therefore be explained as follows: the clusters of species which react unfavourably to high fertilizer dressings die out leaving bare areas while those species, normally randomly dispersed, which have responded to the fertilizer are showing increased vigour and a subsequent increase in number and size and are becoming contagiously dispersed. For example, it has been observed that tussocks of *Themeda triandra* and *Hyparrhenia hirta* die out and only after their death and the dissemination of their litter is the space which was occupied by those tussocks colonized by other species.

Corby (pers. comm.) showed that the further apart the points are the closer the distribution of species approached the Poisson values. Tidmarsh & Havenga (1955) showed experimentally that when the individuals of a population are dispersed at random, the distance between the points must exceed the average diameter of the individual to obtain a close fit to the expected Binomial distribution. The data for Fig. 1a-d were obtained from points spaced at 5 cm intervals. The distributions for plots 1 and 3 have been repeated in Figs 1e and 1f to show the effect of point espacement. The points of the 5 cm bridge were numbered from 1 to 20, and by recording each strike against the point number it was later, by taking alternate points, possible to examine and compare the distributions for the two espacements. The data presented in Fig. 2 are from a plot which has been moderately grazed by sheep and cattle subsequent to an accidental fire. Prior to the fire the veld had been leniently treated and used mainly as a source of hay. A comparison of the figures given for the 5 cm and 10 cm espacements in Fig. 1 shows that in plot 1 the closer fit to the expected values is obtained when the points are spaced at 10 cm, while the non-random distribution given for 5 cm points in camp 3 becomes random when the points are spaced 10 cm apart. In Fig 2a it is seen that the distribution changes from a highly contagious one for points at 1 cm to a somewhat doubtful distribution for points at 2 cm to a random dispersion with points at 5 cm. In the distributions for the 1 cm espacement (Fig. 2b) there is close agreement between the observed values and the Neyman contagion, as one would expect. It is of interest to note that in the distributions for the 2 cm espacement (Fig. 2c), the Poisson values do not differ significantly from the observed values, whereas the Binomial series does not describe the distribution adequately. Because the Poisson distribution is an approximation of the Binomial when the probability of an event occurring is small, it is felt that in this case the Poisson values should be discarded and that it should be accepted that the plants are contagiously dispersed for that particular espacement. The total number of strikes for the three espacements show a fairly close agreement, being 619, 610 and 587 for the

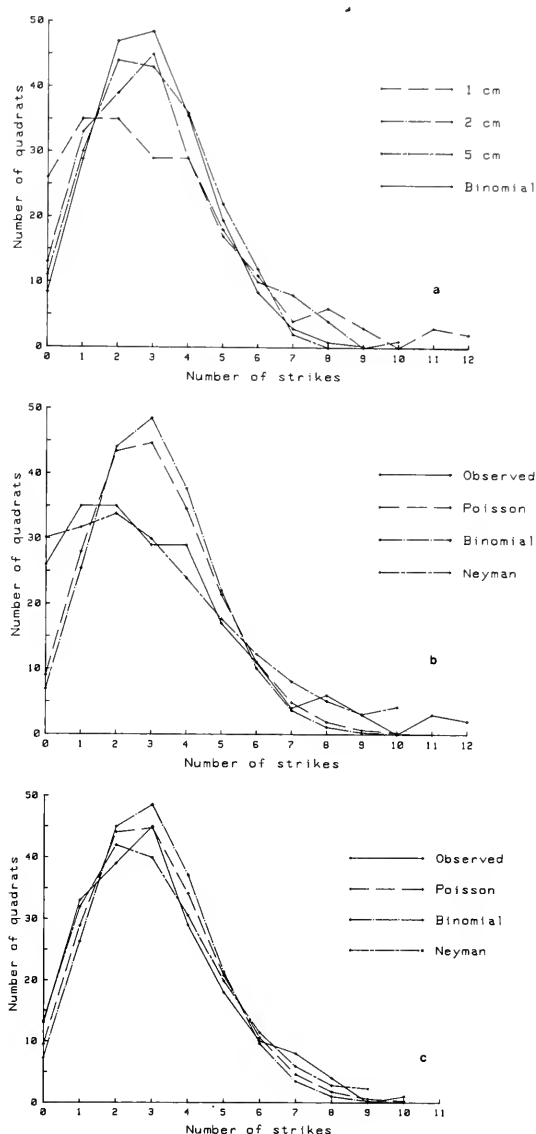


FIG. 2.—a, Comparison of frequency distributions of plants occurring in 200 quadrats, each with 20 variously spaced points, with the expected Binomial curve for 5 cm espacement; b, comparison of the Binomial, Poisson and Neyman series with the actual distribution of plants occurring in 200 quadrats each with 20 points spaced 1 cm apart; and c, of 200 quadrats each with 20 points spaced 2 cm apart.

1 cm, 2 cm and 5 cm espacements respectively. A 't' test showed that the differences between these figures were not significant. It is the writer's contention that a cover made up of evenly dispersed small individuals is more desirable than one of large individuals and correspondingly large bare areas between the individuals, which causes the soil to be more erodable. It is probable that the competition for light and water is less when the dispersion of the plants is uniform. Where clusters are present, those individuals on the periphery of the clusters receive the greater light and water benefits.

Blackman (1935, 1942), Pidgeon & Ashby (1940), Archibald (1948, 1950) and Clapham (1936) have all

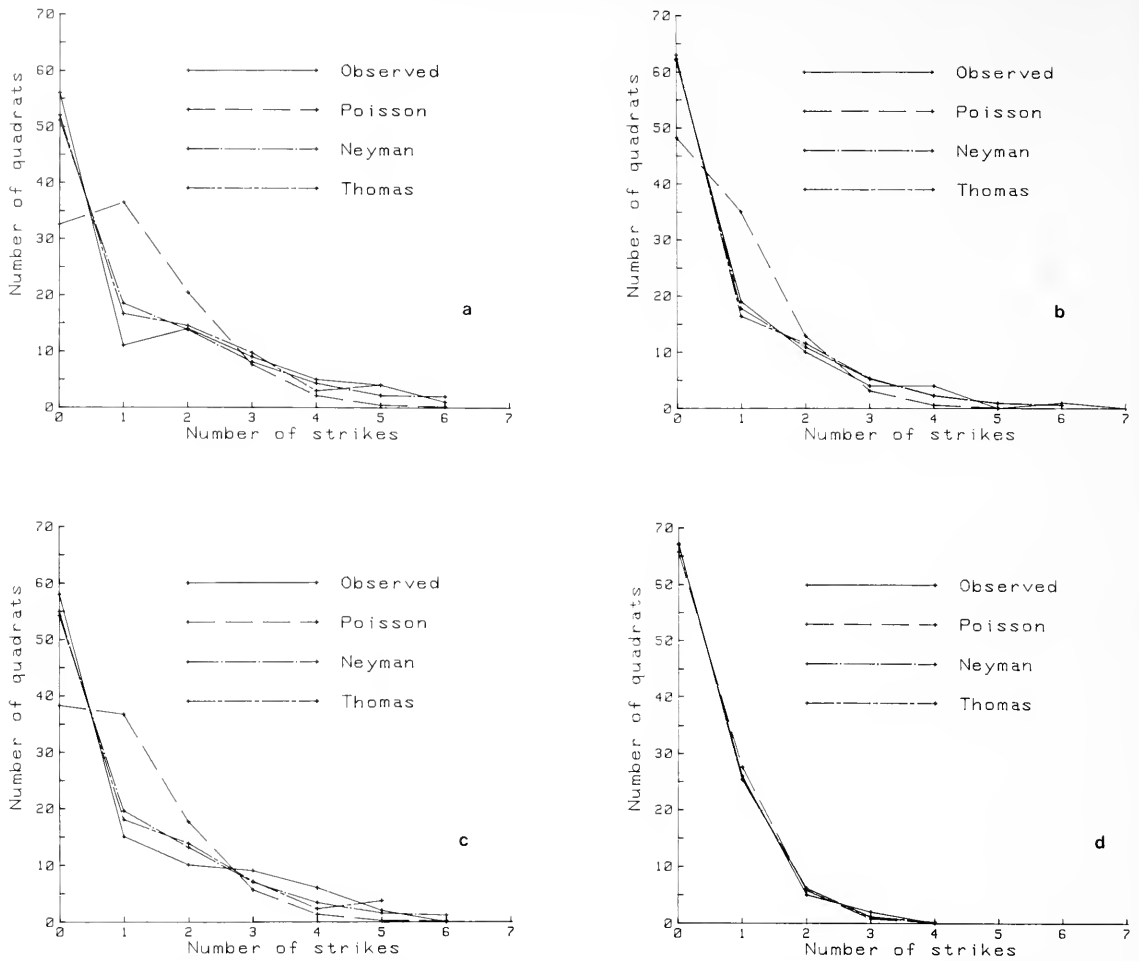


FIG. 3.—Frequency distributions of individual species from plot 5 compared with the poisson, Neyman and Thomas distributions from 100 30-point quadrats with points spaced 5 cm apart; a, *Trachypogon spicatus*; b, *Schizachyrium sanguineum*; c, *Tristachya leucothrix*; and d, *Eragrostis capensis*.

shown that numbers of species in a plant community are not randomly dispersed and that the more abundant a species is, the greater is the degree of aggregation present. Ashby (1948) maintains that it is possible that species, without a biological predisposition to overdispersion, are randomly dispersed when they first occupy an area. Barnes & Stanbury (1951) found that as the vegetation developed, through spreading of 'islands' the distribution becomes highly contagious. If it is accepted that initial colonization is random and that the randomly distributed species later become contagiously distributed, it is reasonable to suppose that subsequent development of the vegetation will take place in, what may be termed as a series of waves of randomness, contagion and a subsequent randomness as the species is replaced. This process would continue until some state of equilibrium is reached where the climax species are contagiously dispersed while the pioneer relics are randomly distributed. Should the succession be driven back, then the reverse process would take place with the pioneer species tending towards contagion and ultimately the climax species would be randomly dispersed. From a series of analyses made at the Rietvlei Research Station, there is evidence which supports the argument propounded above.

Fig. 3 gives four frequency distributions from plot 5 which is rotationally grazed. From observations, this plot may be regarded as climax grassland and is in good 'health'. A bridge with 30 points spaced at 5 cm intervals was laid 100 times at random in the camp. The V/npq ratio is 0.9525 and χ^2 probability lies between 0.8 and 0.9. It will be noted that the distributions for *Trachypogon spicatus*, *Schizachyrium sanguineum* and *Tristachya leucothrix* show a closer agreement to the Neyman and Thomas series than to the Poisson distribution. (When the probability of a plant being struck is very small (i.e. when np is small) then the Poisson series may be used to describe the distribution, however, when np becomes larger it is better to use the Binomial distribution). *Eragrostis capensis*, a relic pioneer is distributed at random, as are many other rare species such as *Brachiaria serrata* and *Eragrostis racemosa* (not plotted). The data for the four species given in Fig. 4 are from plot 3. It will be remembered that the distribution of all individuals in this plot was not random for points spaced at 5 cm intervals (Fig. 1c). *Heteropogon contortus* and *Setaria perennis* may be regarded as species near the climax stage and are overdispersed. *E. capensis* and *E. racemosa* have distributions approaching randomness but are, however, also overdispersed. These

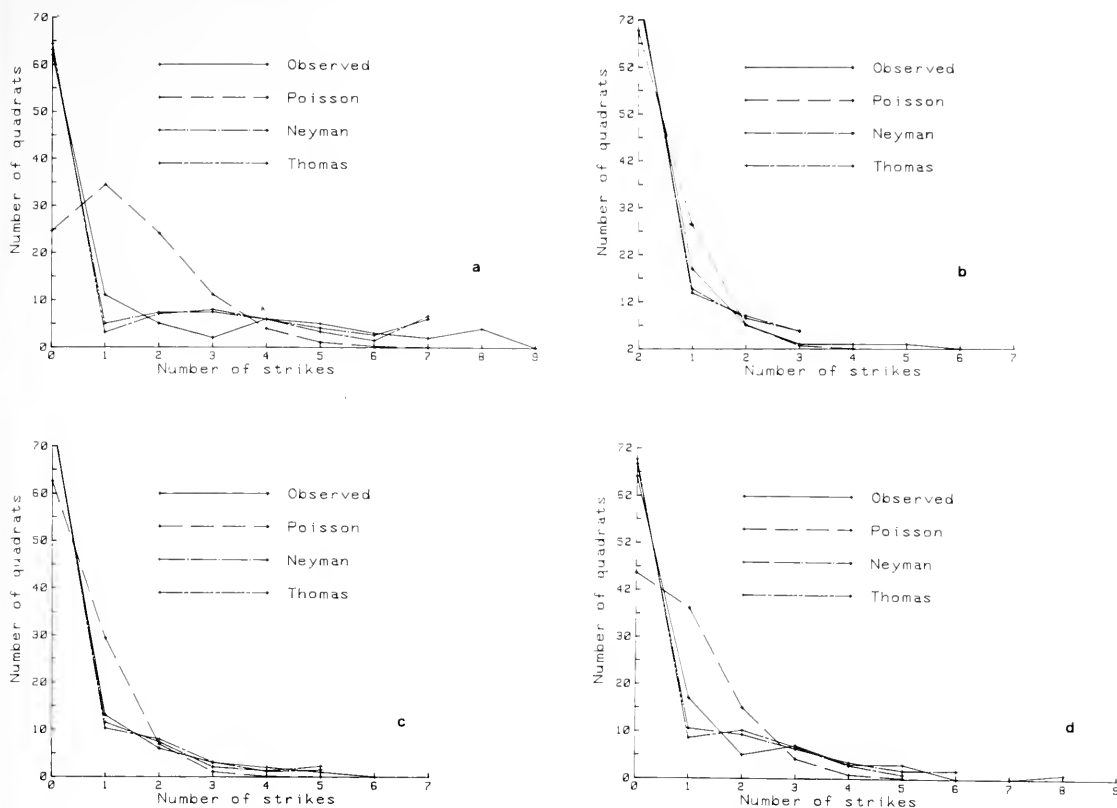


FIG. 4.—Frequency distributions of individual species from plot 3 compared with the Poisson, Neyman and Thomas distributions from 100 30-point quadrats with points 5 cm apart; a, *Setaria perennis*; b, *Eragrostis capensis*; c, *Eragrostis racemosa*; and d, *Heteropogon contortus*.

data suggest that both climax and pioneer species are contagiously dispersed. It has been shown by the writer that some species in which the frequency distribution cannot adequately be described by the Neyman or Thomas series, a better fit can be obtained if the points are moved further apart. It is quite possible that *Setaria perennis* and *Heteropogon contortus* would give a better fit to the contagious series if the points were moved apart. However, with the bridge used for these analysis, it was not possible to use 10 points at 10 cm intervals as there would be too few points to give an adequate representation of the dispersion. It is nevertheless obvious that the distribution is not random for these two species. From Figs 3 & 4 it appears as if the dispersion of the species can make a considerable contribution to the interpretation of botanical analyses, and the assessment of the condition of the sward. In plot 5, in which all plants are randomly dispersed, it is noticed that certain climax grasses such as *Schizachyrium sanguineum*, *Tristachya leucothrix* and *Themeda triandra* are not randomly distributed, whereas grasses near the pioneer stage such as *Eragrostis capensis*, *Brachiaria serrata* and *Eragrostis racemosa* are randomly distributed. The distributions for these last two grasses are not given, but the data indicate that they are randomly dispersed. In plot 3, in which the distribution of all plants is not random, it is found that both climax species and pioneer species are overdispersed.

This paper may be regarded as a preliminary report of certain points which came to notice during routine botanical analyses of grazing experiments on the Rietvlei Agricultural Research Station. It is felt that a deeper insight into the mathematical distribution of species and of individuals will throw light on the mechanism of vegetation changes and the direction in which these changes are proceeding. It is possible that the following points will indicate stability: (a) the frequency distribution of all plants is random when the points are closely spaced, the criterion of spacing being determined by the average size of the plant and the density of the cover; (b) the climax species are contagiously and the pioneer species randomly dispersed. When these conditions are not fulfilled, then there are indications that vegetation changes are occurring and a concept of the magnitude of these changes may be obtained by comparing the observed parameters of the population with theoretical parameters.

REFERENCES

- ARCHIBALD, E. E. A., 1948. Plant populations. I. A new application of Neyman's contagious distribution. *Ann. Bot.* 12: 221–235.
- ARCHIBALD, E. E. A., 1950. Plant populations. II. The estimation of the number of individuals per unit area of species in heterogeneous plant populations. *Ann. Bot.* 14: 7–21.
- ASHBY, E., 1948. Statistical ecology. II. A reassessment. *Bot. Rev.* 14: 222–234.

- BARNES, H. & STANBURY, F. A., 1951. A statistical study of plant distribution during the colonization and early development of vegetation on china clay residues. *J. Ecol.* 39: 171-181.
- BLACKMAN, G. E., 1935. A study by statistical methods of the distribution of species in grassland associations. *Ann. Bot.* 49: 749-777.
- BLACKMAN, G. E., 1942. Statistical and ecological studies in the distribution of species in plant communities. 1. Dispersion as a factor in the study of changes in plant populations. *Ann. Bot.* 6: 351-370.
- CLAPHAM, A. R., 1936. Over-dispersion in grassland and communities and the use of statistical methods in plant ecology. *J. Ecol.* 24: 232-251.
- LEVY, E. B. & MADDEN, E. A., 1933. The point method of pasture analysis. *N. Z. J. Agric.* 46: 267-279.
- NEYMAN, J., 1939. On a new class of 'contagious' distributions applicable in entomology and bacteriology. *Ann. Math. Stat.* 10: 35-57.

- PIDGEON, I. M. & ASHBY, E., 1940. Studies in applied ecology. 1. A statistical analysis of regeneration following protection from grazing. *Proc. Linn. Soc. N. S. W.* 65: 123-143.
- THOMAS, MARJORIE, 1949. A generalization of Poisson's Binomial limit for use in ecology. *Biometrika* 36: 18-25.
- TIDMARSH, C. E. M. & HAVENGA, C. M., 1955. The wheel-point method of survey and measurement of semi-open grasslands and karoo vegetation in South Africa. *Mem. bot. Surv. S. Afr.* 29.

H. H. VON BROEMBSSEN*

*This and the following ecological note were written by the late H. H. von Broembsen of the Botanical Research Institute, Pretoria, who died in 1966. The notes were prepared for publication by J. W. Morris of the same Institute. Address: Private Bag. X116, Pretoria, 0001.

A SIMPLE METHOD FOR DETERMINING THE DENSITY OF PLANTS IN A RANDOMLY-DISPERSED POPULATION

It is sometimes necessary to determine the densities of plants in experimental plots which have been sown to some crop or other. Where the seed has been sown in rows, it is a simple matter to count the number of plants growing in unit lengths of row, and then compute the total number of plants per plot. Where the seed, however, has been broadcast the method in which the density of plants, or the total number of plants per plot, is determined, is different.

When seed is broadcast over a plot, the manner in which the seed falls to the ground is a random process, and the dispersion of the seed over the plot may be described by the Poisson distribution (Feller, 1957). The Poisson distribution is given by

$$P(k \text{ plants growing on unit area } a) = \frac{da^k e^{-da}}{k!}$$

where d is the density of plants per unit area. The probability of zero plants growing in any unit area is then e^{-da} . Now, if n quadrats are placed at random in a plot, and it is found that y quadrats contain no plants then

$$y = ne^{-da}$$

$$\text{and } d = \frac{\log n - \log y}{a \log e} \dots \dots \dots (1)$$

which means that the density of plants may be computed from a knowledge of the total number of quadrats which are used for sampling and the number of quadrats containing no plants. By using this relationship the necessity for counting the number of individuals in the quadrats is eliminated.

When using the relationship (1) care must be taken to choose a quadrat size which will not be, (a) so large that it always contains plants, or, (b) so small that the number of empty quadrats is too large. It is recommended that a rough estimate of the average

density of the individuals first be made over all treatments in the experiment. The size of quadrat which will give the desired percentage of empty quadrats may then be computed from

$$a' = \frac{\log 100 - \log y'}{d \log e}$$

where a' is the area of the quadrat, y' the desired percentage of empty quadrats and d the estimate of average density. It is recommended that y' equal 50 to 60 percent. With y' equal to 50 percent, 34 percent of the quadrats will contain one plant, 12 percent two plants, and four percent more than two plants.

In order to determine the number of quadrats which are required to detect predetermined significant differences in densities the following relationship is used:

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{v}} \sqrt{n} \dots \dots \dots (2)$$

Since the variance (v) of the Poisson distribution is equal to the mean (da), equation (2) may be rewritten in the form

$$n = \frac{2t^2 da}{(d_0)^2}$$

where d_0 is the difference in density you wish to regard as being significant, and $t = 1.96$ for $P = 0.05$, or 2.58 for $P = 0.01$.

The estimates of density should be transformed, using a square root transformation, before being subjected to an analysis of variance.

REFERENCE

- FELLER, W., 1957. *An introduction to probability theory and its applications*. New York: Wiley.

H. H. VON BROEMBSSEN

A NOTE ON THE EXTENSION OF THE DEGREE REFERENCE SYSTEM FOR CITING BIOLOGICAL DISTRIBUTION RECORDS TO NORTH OF EQUATOR AND WEST OF GREENWICH MERIDIAN

The Degree Reference System proposed by Edwards & Jessop (1967) and Edwards & Leistner (1971) has been in general use in South Africa for well over ten years. Attention has recently been drawn to a requirement for extending the System for plotting the distribution of plants for the whole of Africa and for surrounding islands such as Tristan da

Cunha and Marion Island. This means extension to both north of the Equator and west of the Greenwich Meridian, amounting to extension to cover the rest of the earth's surface. Although such an extension was implied by Edwards & Leistner (1971), no formal conventions for doing so were proposed by them. This Note gives a simple procedure for differen-

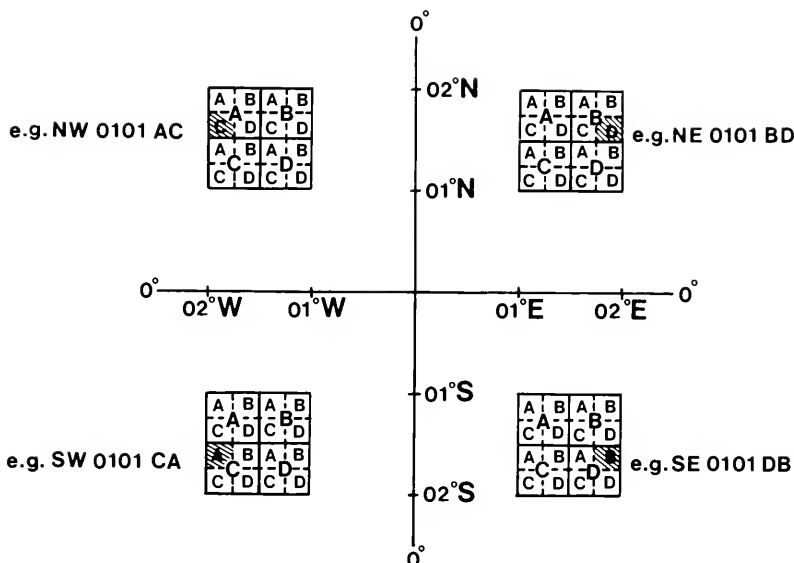


FIG. 5.—Example of numbering for different quadrants north or south of Equator and east or west of Greenwich Meridian.

tiating, when required, between the different quadrants of the earth's surface.

As reported by Edwards & Leistner (1971), since we happen in Africa south of the Equator to be in the south-eastern quarter of the earth's surface in relation to the intersection of 0° latitude and 0° longitude, the degree square is numbered according to the degrees of latitude and longitude, in that order, of the top left hand or north-west corner of the degree square. By extending this principle, degree squares in the north-eastern, north-western and south-western quarters of the earth's surface may be numbered in relation to the point of origin in a way similar to that of the south-eastern quarter, provided the various quarters are identified by prefixing the letters NE, NW, SW and SE to the degree numbers. In other words, the degree squares are numbered just as the latitude and longitude are numbered on a map, with the addition of prefixes indicating N or S of the equator and E or W of Greenwich meridian. This is illustrated in Fig. 5.

If required, subdivision of the degree square is then carried out in exactly the same way as previous-

ly: by subdividing into half-degree squares numbered A, B, C and D, respectively, and each half-degree square being further subdivided into quarter-degree squares, again numbered A, B, C, and D, respectively. This is also illustrated in Fig. 1.

In general, use of the Degree Reference System is therefore similar throughout the world, latitude and longitude numbers being used as found on a map, but with the prefixing of the letters N or S and E or W to indicate, respectively, north or south latitude, and east or west longitude. Subdivisions of a degree square are then made by successive division into half- and quarter-degree squares, which are indicated by the letters A, B, C, and D.

REFERENCES

- EDWARDS, D. & JESSOP, J. P., 1967. Proposed replacement of magisterial districts by a latitude-longitude grid system for plant distribution by the Botanical Research Institute. *S. Afr. Forum Botanicum* 5: 1-5.
EDWARDS, D. & LEISTNER, O. A., 1971. A degree reference system for citing biological records in southern Africa. *Mitt. bot. StSamml., Münch.* 10: 501-509.

D. EDWARDS

DETERMINATION OF PLOT SIZE

In most vegetation studies a plot technique is used for sampling. In many studies it is required that each plot must be large enough to contain the 'characteristic structure and floristics' of the phytocoenose. The determination of plot size has occupied the attention of many plant ecologists; the general conclusion being that 'an objective method of plot size determination seems impossible' (Werger, 1972). Werger (1972) and Moravec (1973) have reviewed these studies.

In this paper a regression equation relating optimal plot size (Werger, 1972) to easily measured vegetation characteristics is constructed. If this regression equation could be improved and tested more widely it could form the basis of a rule-of thumb method to estimate optimal plot size in the field.

The methods of Werger (1972) were used to determine the optimal plot size of 32 phytocoenoses.

Werger's definition of optimal plot size is that size which contains a specified percentage of the number of species calculated to occur in one hectare. Therefore if there are 80 species in one hectare (100% information), and if 50% information is required, then optimal plot size is that area which contains 40 species. Werger (1973) used 50-55% information in his phytosociological studies in South Africa. The regression equation

$$y = a + b \log_e x$$

(Gleason, 1925; Goodall, 1952) was used in the present study and by Werger (1972), to calculate the number of species in one hectare of the sampled vegetation (y is the number of species in area x , and a and b are constants that are calculated with each set of x , y values from every phytocoenose). The data to

calculate optimal plot size came from nested circular plots of sizes varying between 0,8 m² and 1256 m² in 12 of the 32 phytocoenoses, and from nested rectangular plots of sizes varying between 1 m² and 256 m² in the remaining phytocoenoses.

For each of the 32 phytocoenoses the following vegetation characteristics were recorded:

- (1) H = maximum height (m) of the tallest stratum.
- (2) T = total projected cover (recorded in 10 classes 1 = 1–10% cover, 2 = 11–20% cover, . . . and so on 10 = 91–100% cover).
- (3) C = projected cover of the tallest stratum (recorded as for T).
- (4) Number of species in 200 m² (usually determined by extrapolation of the species-area regression equation).
- (5) Number of strata (for this particular vegetation characteristic a stratum had to have more than 25% cover to qualify as a stratum).
- (6) % species in the tallest stratum.

The phytocoenoses that have been used cover a range of vegetation types in South Africa, chiefly the semi-desert vegetation of the Karoo (n = 10) and the fynbos of the Cape winter-rainfall region (n = 17). Also represented are grassland (n = 2), and woodland and forest (n = 3). Fifteen of the phytocoenoses used are from Werger (1972).

Vegetation structure has long been known to affect plot size (refer to Werger, 1972, for further discussion). Therefore it is not surprising that height of the tallest stratum (H), total cover (T), and cover of the tallest stratum (C), are all significant ($p < 0,005$) in the regression equation relating optimal plot size to vegetation characteristics.

Vegetation height is usually positively correlated with average crown diameter. The larger the diameter, the larger is the average interplant spacing; therefore height of vegetation is positively correlated with optimal plot size.

Because of the greater interplant spacing in vegetation with low total cover, or in vegetation in which the tallest strata have low cover, optimal plot size is negatively correlated with these vegetation characteristics.

Of the various possible regressions relating optimal plot size to vegetation characteristics, the most successful were the following (various transformations of the original variables were attempted but proved less successful):

For 40% information per plot ($r^2 = 0,51$):
 $P = 32,4 + (2,0) (H) - (1,5) (T) - (1,5) (C)$
 For 50% information per plot ($r^2 = 0,50$):
 $P = 80,7 + (4,6) (H) - (3,3) (T) - (3,5) (C)$
 For 55% information per plot ($r^2 = 0,48$):
 $P = 127,4 + (6,8) (H) - (4,8) (T) - (5,3) (C)$
 For 60% information per plot ($r^2 = 0,46$):
 $P = 199,8 + (10,0) (H) - (6,6) (T) - (8,1) (C)$

where P is the optimal plot size (m²) and H, T and C are as given above.

The r^2 values indicate that only half of the variation in the calculated values of optimal plot size is accounted for by the three vegetation characteristics in the regressions. The r^2 values could probably be improved if more sophisticated vegetation characteristics could be used (e.g. direct measures of crown diameter, crown overlap, and cover by vegetation strata). Much of the variation in optimal plot size which is not accounted for may be due to the errors that arose when determining the vegetation characteristics of the 15 phytocoenoses reported by Werger (1972). We had to glean our information for these phytocoenoses from Werger (1972) and Werger (1973); we were unable to do any field recordings for his work. We would also suspect an improvement in the r^2 values if more than one species-area curve had been constructed in each phytocoenose.

It is difficult to explain the lack of correlation between optimal plot size and floristic richness (here measured as number of species in 200 m² – $P > 0,4$). One would have suspected a positive correlation (Werger, 1972).

Choice of plot size is often dictated by success or failure of previously used plot sizes. Therefore, for example, in regions with a long history of phytosociological research plot sizes that are suitable are listed by vegetation type (e.g. Mueller-Dombois & Ellenberg, 1974: p. 48). In the numerous regions where phytosociological studies are yet to begin, a regression equation that relates optimal plot size to vegetation characteristics could be of use. Therefore if the regressions of the type reported in this paper could be improved, as we feel they could, a phytosociologist could calculate optimal plot size by determining a few, easily measured vegetation characteristics.

We thank the C.S.I.R. for funding this project, and Dr M. J. A. Werger for valuable comments.

REFERENCES

- GLEASON, H. A., 1925. Species and area. *Ecology* 6: 66–74.
 GOODALL, D. W., 1952. Quantitative aspects of plant distribution. *Biol. Rev.* 27: 194–245.
 MORAVEC, J., 1973. The determination of the minimal area of phytocoenoses. *Folia Geobot. Phytotax. Praha* 8: 23–47.
 MUELLER-DOMBOIS, D. & ELLENBERG, H., 1974. *Aims and methods of vegetation ecology*. New York: John Wiley & Sons.
 WERGER, M. J. A., 1972. Species-area relationship and plot size: with some examples from South African vegetation. *Bothalia* 10: 583–594.
 WERGER, M. J. A., 1973. *Phytosociology of the upper Orange River Valley, South Africa*. Ph.D. thesis, University of Nijmegen.

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REVIEW OF THE WORK OF THE BOTANICAL RESEARCH INSTITUTE, 1979/1980

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INTRODUCTION

The need for botanical research to supply answers to problems in connection with the management, optimal utilization and conservation of the plants and vegetation cover of southern Africa is becoming more evident as environmental problems increase. For this reason a greater concentration of manpower on taxonomic and ecological research has proved to be necessary. In the ecological field priority areas receiving much attention were the fynbos of the winter rainfall area of the Cape and the coastal aquatic and adjacent terrestrial habitats. The difficult field of rootgrowth research yielded some interesting results but will need a great deal of further effort. More research on ecophysiology and the

dynamics of vegetation have become essentials for progress.

The venture by the Department into palaeobotanical research, even though a new departure, is a natural extension of the series of botanical inventories for different plant groups represented by the Flora of Southern Africa.

A highlight of the year was the declaration of the Pretoria Botanic Garden as a National Monument, an indication that it is recognized as a valuable asset as well as an indispensable part of the research organization of the Department.

This review covers a nine-month period, from 1 July, 1979 to 31 March, 1980.

REPORTS OF THE SECTIONS

HERBARIUM SERVICES SECTION

The four herbaria of the Institute continued to identify plants and provide information for a wide range of people including officers of the Institute, various State and Provincial Departments, universities and the public both in South Africa and neighbouring states.

National Herbarium, Pretoria (PRE)

A total of 13 285 specimens was named and 430 visitors dealt with. Accessions to the herbarium numbered 19 377. During the year 37 loans (7 498 specimens) were sent out to other institutes and 18 loans (1 820 specimens) were received. We received 1 055 specimens on exchange, but did not distribute any duplicates during the period.

Due to the lack of rain in the western half of the country, no major expeditions were undertaken. Several minor collecting trips were made in the eastern Transvaal, northern Natal and eastern Orange Free State. Problems were again experienced with organizing a major expedition to Lesotho. This was again cancelled at the last moment.

A reorganization of the herbarium (Fig. 1) took place with the establishment of a separate cryptogamic herbarium. The collections were moved to accommodation vacated by workshops in the basement. The establishment of a fossil herbarium in the garages under the Library has been necessitated by the rapidly expanding activities and collections in the palaeobotanical field. Our modular steel cabinets were redesigned internally to accept 40 removable trays to carry the fossil specimens.

Among the numerous visitors who came to consult the collections and staff were the following: Dr Fred Hoener (Lesotho: American Peace Corps), Prof. D.

and Dr U. Müller-Doblies (Berlin), Dr Juliet Prior (London: Swaziland Archaeological Association), Mr B.K. Simon (Queensland, Australia), Dr. M. Schrieber (Regensburg), Mr R.B. Drummond and Mr L.C. Leach (Salisbury).

Wing A: Mrs E. van Hoepen continues to control the Wing in a part-time capacity while controlling the information and identification service.

Miss C. Reid is co-operating with Mr T. H. Arnold in the preparation of a preliminary revision of *Ficinia* (Cyperaceae), which is required for ecological research in the Fynbos Biome Project.

Miss L. Smook and Dr G. E. Gibbs Russell are continuing with sorting and re-evaluating the data bank records for Poaceae.

A fair amount of expansion was possible in the Wing due to the removal of the cryptogamic collections.

Wing B: Mr G. Germishuizen is nearing completion of his revision of the southern African members of Polygonaceae, which will be submitted as an M.Sc. thesis to the University of Pretoria. He has completed the botanical text for a book on medicinal and edible plants and is currently doing the text for an illustrated book on the Wild Flowers of the Transvaal with paintings by the artist Anita Fabian.

Mr D. A. Davies was transferred to the regional herbarium in Stellenbosch to assist with the herbarium work. His place was taken by Mr B. D. Schrire who will be transferred to Durban later in 1980.

Wing C: Miss E. Retief is continuing her revision of Campanulaceae. She has been involed with Mr P. P. J. Herman in a survey of the seed samples in the seed collection using the scanning electron micro-

scope. She presented a poster paper on the subject in conjunction with Mr Herman at the S.A.A.B. Congress in Pietermaritzburg in January.

Mr Herman is nearing the end of his work on *Pavetta*.

Mr C. Hildyard completed successfully his first year courses for his B.Sc. degree at the University of Pretoria.

Wing D: Mr G. J. Goosen left at the beginning of the year to take up a post with Nature Conservation at the Etosha Pan Game Reserve.

Miss W. G. Welman continues as the regional abstractor for *Excerpta Botanica* (Taxonomica).

Cryptogams: The establishment of the cryptogamic herbarium in the basement is very welcome. The change-over to the vertical packeting system and the roll-out card index cabinets has been a great improvement in respect to space saving and ease of handling. The repackaging of the mosses and liverworts is now complete.

A total of 2 971 specimens was identified and 3 604 were added to the collection. Only 8 specimens were sent out on loan. Exchanges amounted to 3 038 sent out and 484 received.

Dr R. E. Magill attended the International Bryological Congress in Geneva in September chairing several sessions. Thereafter he visited Paris, Kew and the British Museum in search of types. He recently completed his treatment of 200 species for the Flora.

Mr J. van Rooy is continuing with his revision of *Bryum* for the Flora. He should obtain his B.Sc. degree at the end of 1980.

Mr F. A. Brusse joined the herbarium in February to work on Lichens. His M.Sc. thesis on *Xanthoparmelia* has been submitted to the University of the Witwatersrand. He is presently checking the whole collection and supervising its repackaging and reorganization.

Natal Herbarium, Durban (NH)

A total of 1 318 specimens was named and 725 visitors dealt with. Among the latter were student and school groups. Accessions to the herbarium numbered 1 980. Some 1 667 specimens in 5 batches were sent out on loan to various institutes.

Mr P. V. C. du Toit left the herbarium at the end of the period on transfer back to the Pasture Research Section of Natal Region of the Department at Cedara. He joined the staff of the Institute in 1972 and took charge of the Natal Herbarium in 1976.

Mrs B. J. Pienaar returned to the herbarium after a 6 months training period in Pretoria.

Miss A. Wright left in January to continue her studies at University. She was succeeded by Mrs L. Nichols who for a number of years had worked in the Compton Herbarium, Kirstenbosch.

Albany Museum Herbarium, Grahamstown (GRA)

A total of 2 012 specimens was named and 522 visitors dealt with. Accessions to the herbarium numbered 1 276. Some 381 specimens in 15 batches were sent out on loan to various institutes.

Among the visitors who came to the herbarium were Prof. D. Müller-Doblies (Berlin), Dr C. Vosa (Oxford), Dr Sylvia Earle (California) and Dr W. Farnham (Portsmouth, England) consulted the Pocock algal collection.

Mrs E. Brink continues to run the herbarium with Miss G. V. Britten, now in a morning post, to assist her. No one has been appointed to the vacant technical assistant post.

A brief training course has been instituted for the African assistants in the local section of the Provincial Department of Nature Conservation. This has been done mainly by Alfred Booï, the herbarium's African assistant, who produced a training manual in the vernacular for the purpose.

Government Herbarium, Stellenbosch (STE)

The number of specimens named totalled 3 210 with 178 visitors requiring information. Accessions to the herbarium numbered 1 204. In all 21 loans of 2 672 specimens were sent out.

Mrs M. F. Rand left the herbarium at the end of December for maternity reasons. She started work in the herbarium in January 1965 and much of the credit for the building up of the herbarium to its present state must go to her. She hopes to continue her research on Hypoxidaceae at the Compton Herbarium, Kirstenbosch.

Miss L. Hugo assumed duty as Curator. She will soon begin revisionary work on *Tetraria* (Cyperaceae). Mr D. A. Davies was transferred down from Pretoria in February to assist with the curating and identification service. Miss M. Schonken began work in the herbarium in March. She is currently completing her research on a group of species in *Pelargonium* for her M.Sc. degree at the university of Stellenbosch. The increase in staff is as a result of the increasing demands on the identification service made by the Fynbos Ecosystem Project of the CSIR.

A quick turnover in technical assistants has taken place during the last few years. The present incumbent Mrs R. Wikner is proving invaluable.

S.W.A. Herbarium, Windhoek (WIND)

This herbarium which was a regional herbarium of the Botanical Research Institute from 1954, was eventually transferred to the Administration of S.W.A./Namibia. It is now an independent herbarium in southern Africa with Mr M. A. N. Müller continuing as Curator. We wish him and his staff all of the best for the future.

FLORA RESEARCH SECTION

Flora of Southern Africa

Two parts of the Flora were published. The first is Vol. 10, part 1 dealing with 54 species of the families Loranaceae and Viscaceae. Line drawings and distribution maps are provided for most species. The work was done by Prof. D. Wiens of the University of Utah, U.S.A. and Dr H. R. Tölken, formerly of this Institute and now at the State Herbarium, Adelaide, Australia. The second is Vol. 27, part 4 which treats 130 species of the genera *Brachystelma*, *Ceropegia* and *Riocrexia* in the family Asclepiadaceae. The work was done by Dr R. A. Dyer who recently retired for the second time from the Institute (his first retirement was in 1963).

Two volumes in the series on Cryptogams are progressing well: Vol. 14 (Bryophyta): Fascicle 14.1, 1 covering the families Sphagnaceae to Grimmiaceae has been submitted to the editor by Dr R. E. Magill. It deals with 190 species, each of which is accompanied by a detailed pencil drawing and a distribution map.



FIG. 1.—The main building of the Botanical Research Institute, Pretoria.

Vol. 15 (Pteridophyta): The 250 species of ferns are being written up by Prof. E. A. Schelpe of the Bolus Herbarium of the University of Cape Town. Texts of about 80 species have been submitted to the editor for criticism and the work should be completed by the end of 1981.

In the series on Flowering Plants the following volumes or parts thereof are at a final stage of preparation or have been submitted to the editor:

Vol. 3: Dr P. J. Vorster of the University of Stellenbosch put further finishing touches to his completed thesis on the 65 species of *Mariscus* and related genera.

Vol. 4: Part 2 on 42 species of the families Mayacaceae to Juneaceae has been submitted to the editor. Only the genus *Aneilema* (Comelinaceae) has still to be completed. Authors of this part are Mrs A. A. Mauve, Prof. J. P. M. Brenan (K), Mr J. Lewis (BM) and Dr R. Faden (F).

Vol. 7: Prof. M. P. de Vos of the University of Stellenbosch has offered to adapt her revision of *Romulea* to Flora format early in 1981.

Vol. 11: The revisions of *Lampranthus* and *Gibbaeum* (Mesembryanthemaceae), completed by Dr H. F. Glen, will appear in the Contributions of the Bolus Herbarium soon.

Vol. 14 (Crassulaceae): As reported before, a revision of the genus *Crassula* in southern Africa has been published in the Contributions of the Bolus Herbarium and the rest of the text on the 400 species of the volume is with the editor. Publication is delayed, however, as attempts are being made to align the work with treatments of the family presently being prepared for the Flora Zambesiaca and the Flora of Tropical East Africa.

Vol. 18,3: This fascicle will comprise Simaroubaceae to Malpighiaceae, a total of 45 species. Prof. J. J. A. van der Walt of Stellenbosch University is adapting his publication on Burseraceae to Flora

format and Mr F. White of the Forestry Herbarium, Oxford, will do the same for his publications on Meliaceae and Pteroxylaceae. The other families are being written up by Miss K. Immelman.

Vol. 21: Tiliaceae by Prof. H. Wild is being edited. Most parts of Sterculiaceae prepared by Dr I. C. Verdoorn are being published in Bothalia. The major part of *Hermannia* has already appeared.

Vol. 28: Dr L. E. Codd has completed most of the work on a fascicle of the Lamiaceae, a family comprising about 250 species.

Brief mention can be made of some volumes on which active research is in progress in the Institute.

Vol. 2: Poaceae (Dr G. E. Gibbs Russell).

Vol. 5: Liliaceae (Mrs A. A. Mauve).

Vol. 10: Polygonaceae (Mr G. Germishuizen).

Vol. 11: Mesembryanthemaceae (Dr H. F. Glen).

Vol. 15: Rosaceae — *Rubus* (Mr C. H. Stirton).

Vol. 16: Fabaceae — *Eriosema* (Mr C. H. Stirton).

Vol. 25: Ericaceae (Mr E. G. H. Oliver).

Palaeoflora of Southern Africa

A revision of the genus *Dicroidium* (extinct seed ferns) comprising some 20 species is being prepared as Volume 1 of the Palaeoflora series by Drs John and Heidi Anderson. Material was largely derived from 45 localities spread throughout the Molteno Formation. The 50 mosaic photographic plates illustrating the reference populations have been prepared and the text is two-thirds completed.

A Palaeobotanical Herbarium has been established at the Institute and the fossil collections are now housed in 20 specially designed cabinets. The collection has been recatalogued with the prefix PRE/F and comprises some 5 000 specimens to date.

Register of plant taxonomic projects

A new edition of this register, listing more than 300 current projects on African plants, was completed and distributed world-wide in microfiche form.

Botanical collectors in Southern Africa

The initial write-up of this work, which is being written by Miss M.D. Gunn and Dr L. E. Codd, is complete. Part 2 of the work (Dictionary Botanical Collectors) is being set up for the publisher on an IBM compositor. The text of Part 1 (Historical introduction) is being revised in places.

Southern African Plants

Brochures on 20 of the most important water plants are in press. Proofs of the text have been read and publication of all brochures is expected before the end of 1980.

Pretoria Flora

Texts of 195 species (including the family Fabaceae) were typed. Material of a further 120 species is ready for typing. Texts of 291 species were re-written and are almost ready for typing. Five artists and twelve researchers of the Institute have contributed to the work.

Liaison officer, Kew

The present incumbent, Mr C. H. Stirton, continued with research on the taxonomy of *Rubus*, *Lantana* and various genera of Fabaceae. In addition, he checked on the nomenclature of the species to be included in the National Weed List and dealt with numerous queries from the Institute and from universities and other institutions, both in the R.S.A. and overseas.

PLANT STRUCTURE AND FUNCTION SECTION

Until recently the disciplines of plant anatomy and cytogenetics were the responsibility of the Flora Research Section. These functions have now been accorded sectional status and, together with the envisaged development of plant physiological studies and facilities at the Botanical Research Institute, should form the basis of expanding applied taxonomic and biosystematic studies.

Plant anatomy

The grass leaf anatomy project, the main project being undertaken by Mr R. P. Ellis, continued to yield interesting results in the genus *Merxmüllera* (= *Danthonia*) where the comparative anatomy of the summer-rainfall species has been completed. These studies have clearly shown that in the Drakensberg region there has been extensive diversification of this genus with the basic *M. stricta* and *M. disticha* lines showing parallel anatomical and ecological adaptations to the various habitats inhabited by these species in this area. From the results of this study it appears as if several taxonomic adjustments are needed to the current classification of these *Merxmüllera* species.

During 1979 Miss Riana Manders was seconded to the University of Pretoria where she was awarded her B.Sc. Hons degree. After relieving in the Data Processing Section for six months she will concentrate on the applied aspects of grass leaf anatomy, particularly dietary studies in grazing herbivores using histological analysis.

Cytogenetics

The major research conducted during the review period has been undertaken by Mrs Wilma Gaum of the Plant Exploration Section as part of the weed research programme of the Institute. Her cytogenetical studies have concentrated on *Lantana camara* and

the genus *Rubus* and form part of detailed biosystematic studies being co-ordinated by Mr C. H. Stirton. Results have confirmed that *Rubus* forms a polyploid series with the basic chromosome number of $x=7$. The diploid species exhibit normal meiotic chromosome behaviour which indicates that they are completely fertile — a fact confirmed by embryo sac analysis. Many of the polyploids, on the other hand, display relatively abnormal meiosis.

The cytogenetical aspects of the cytotaxonomic study of the *Eragrostis curvula* complex have been completed. Seed of all the specimens examined cytogenetically in this project has been lodged with the Seed Bank of the Plant Protection Research Institute. This project has been written up in the form of a thesis for which Mr T. B. Vorster has been awarded his D.Sc. degree.

ECOLOGY SECTION

The function of the Ecology Section, formerly known as the Botanical Survey Section, is to study the vegetation of South Africa and its ecological relationships. This work covers three main fields of activity: (1) The identification, description and mapping of various vegetation classes; (2) The study of the ecological relationships between different types of vegetation — mutually and with the environment — and also of the various processes and mechanisms that govern the behaviour of plant communities; (3) The development of various methods and techniques required for ecological studies of vegetation.

Veld types of South Africa

This project has been dealt a severe blow by the passing of the late Mr J. P. H. Acocks. The great quantity of processed and semiprocessed data as well as his original observations have been sorted and safely housed at the Botanical Research Institute, Pretoria. Here they represent an incomparably comprehensive collection of past and present vegetational and environmental data. The formidable task of further processing this data base and exploiting its potential to the full awaits an improvement in available manpower.

Transvaal bushveld studies

To complement earlier work on this programme, Mr R. H. Westfall has started work on a project to study the ecology of the Sour Bushveld (Veld Type 20). This veld type is starting to undergo greater intensification of agricultural and other uses and rational planning for multiple-use management must be set in motion. Increasing intensification of agriculture must be reconciled with other sometimes conflicting but valid needs such as nature conservation and recreation. Field work on this project started in 1980 and by the end of March 132 quadrats had been sampled.

Coastal studies

Dr P. J. Weisser studied the seaward advancement of the dunes at Mtunzini, Natal by comparing aerial photographs taken from 1937 to 1977. Dunes advanced by an average of 95.2 m, at an average rate of 2.4 m per year.

The vegetation of the Wilderness Lakes in the Cape Midlands and the water-plant encroachment problem were also studied by Dr Weisser. An increase of emergent water plants and a decrease of submerged water plants was detected in localized areas. This is related to the lower water levels owing

to the artificial opening of the Wilderness Lagoon mouth, in addition to natural succession.

Messrs H. C. Taylor and C. Boucher, Dr P. J. Weisser and co-workers are participating in a worldwide study of dry coastal ecosystems. The floristic information gathered from more than 250 relevés is being processed by Braun-Blanquet phytosociological methods to identify plant communities of dry coastal ecosystems of South Africa and to interpret their environmental relationships. The communities of the rocky coasts are certainly different from those of the dunes, but the dune vegetation appears to be more complex than was previously thought.

Miss B. K. Drews conducted a reconnaissance of conservationworthy areas of fynbos in the Knysna-Wilderness-Plettenberg Bay Guide Plan Area for the former Department of Environmental Planning and Energy to provide the basis for the protection of natural areas. A report and map were produced recommending that 13 areas be identified as natural areas.

Vegetation survey of the Cape of Good Hope Nature Reserve

Mr H. C. Taylor has completed the field work for assessing the rate of infestation of plant invaders over a ten-year period. This entailed relocating 27 permanent sample plots and re-enumerating the invader density on them.

A primary survey of Rooiberg Mountain Catchment Reserve near Ladismith, Cape

The structural units and floristic associations identified by Mr Taylor during this survey closely correlate with each other, and their distribution reflects the major environmental influences, aspect and altitude. He concludes that, despite the preliminary character of the survey, resource inventories of this type are suitable as a foundation for park management.

In another study, he has shown that the Rooiberg flora has strong affinities with the eastern fynbos element and with the dry fynbos of the inland mountain ranges.

Hakea project

Mr S. R. Fugler has submitted his findings in the form of unpublished reports, parts of which may be published in due course. He concludes that *Hakea* encroachment can be controlled subject to availability of funds and manpower. Ecological principles are currently being applied to find practical methods of effecting control.

Physiognomic classification of mountain fynbos

Mr B. M. Campbell has completed the field work for the classification. This consisted of 508 plots located on 20 transects throughout the mountains. In each plot detailed information on structure and function (growth-form, height classes etc.), environment and floristic composition (dominant species etc.) was collected. All the structural-functional and environmental data have been edited, coded and placed on computer file ready for analysis. The dominant species are being identified, and the floristic data are being coded.

A study of the vegetation along transects through the western Cape foreland

Mr C. Boucher and Mr P. A. Shepherd have completed sampling of the natural vegetation along four

transects through the western Cape's coastal foreland. Two hundred floristic and two hundred physiognomic relevés and 614 specimens were collected. All the data were coded for computer analysis. The preliminary results from the analysis of the first transect indicate that all three of Acocks's veld types found in the area can be clearly distinguished. A more detailed analysis is not possible until a larger percentage of the specimens collected have been identified.

Orothamnus project

The annual monitoring of *Orothamnus zeyheri* ('marsh rose') populations in the Kogelberg State forest was undertaken by Mr C. Boucher during January 1980. Phenological growth-rate and population-size data were recorded. Two new populations were found. The total number of plants counted compares favourably with the maximum population size previously known, if it is considered that between nine and twelve years have elapsed since regenerative treatments were originally applied and the *O. zeyheri* normally has a lifespan of less than 23 years.

Aquatic ecology

Classification and mapping of aquatic macrophyte communities of Natal

Mr C. Musil's preliminary classification of the water-plant communities of Natal is completed. Water-plant communities are grouped into five categories based on their habitat preference and tolerance of water salinity and its acidity or alkalinity. The categories are marine, estuarine, brackish water, moderately fresh to slightly brackish water, slow-flowing and fast-flowing fresh-water communities. The distribution of the communities, included within each category, are mapped and their composition and environmental tolerances are discussed.

An ecophysiological study of water hyacinth in Natal

Mr Musil's findings on water hyacinth (*Eichhornia crassipes*) have been synthesized and the final report is being prepared. Growth constants determined in culture cannot be used to predict growth rates of plants in the field. Growth rates in the field are high with an average mass doubling time of 3 days in eutrophic situations. Growth is highly correlated with radiation, temperature and relative humidity. The density of the water hyacinth populations influences the rate of growth and chemical composition of plants.

National Conservation Plan

The work of Dr J. C. Scheepers and Miss B. K. Drews on the NAKOR National Plan for Nature Conservation has mainly entailed the handling, storage and mapping of data on conserved areas in South Africa, and the establishment of a computer data bank. At present, this data bank stores information on about 300 existing and 100 proposed conservation areas. These data are available for retrieval and processing in various ways for planning purposes.

DATA PROCESSING AND ECOSYSTEM STUDIES SECTION

This will probably be the last report by this Section in its present form as Dr J. W. Morris has been transferred to Datametrical Services (Head Office) and an internal re-organization of sections will be carried out in the near future. The mandate of this

Section is the provision of data processing facilities for research purposes to the rest of the Institute as well as undertaking plant ecological research at the ecosystem (function) level. The largest data processing task to be undertaken, the computerization of the National Herbarium, is now complete. Our contribution to the Savanna Ecosystem Project at Nylsvley, determination of biomass relations and seasonal biomass change in dominant tree and shrub species has made good progress and a number of reports on biomass relations have been published. The Savanna Ecosystem Project data bank is administered by this Section, under the control of Dr J. W. Morris. He is also responsible for co-ordination of modelling activities as well as research in the Decomposer and Nutrient Cycling Components of the Project.

The National Herbarium Data Bank (PRÉCIS) has changed to the status of a production system and already useful results are being obtained from it. The production of maps showing the distribution of specimens selected from the data bank is a facility which has been added.

Further work on savanna root growth by Dr M. C. Rutherford has given valuable results using a sophisticated root observation chamber. The chamber incorporates a microscope and travelling carriage enabling precise observations of the activity of the belowground plant component that is important to the functioning of savanna vegetation as a whole. Pioneering work on the effects of plant water status on the radial growth of bushveld trees has also been carried out by Dr Rutherford. Techniques have included the severing of tree trunks held in position while simultaneously monitoring various properties of the tree trunk and leaves.

PLANT EXPLORATION SECTION

The Economic Botany Section under Mr M. J. Wells has changed its name to the Plant Exploration Section, as a result of the responsibility for weed research having been moved to the new Weed Research Unit in the Plant Protection Research Institute. Despite this organizational move it is anticipated that botanical aspects of weed research will continue to be handled by officers seconded to the Institute for many years to come.

The accent in the past year has been on developing new fields in plant exploration research under the team leader Mr T. H. Arnold, whilst concentrating most of our weed research effort on the compilation of the National Weed List, which we regard as basic to future research development.

The origin and evolution of Sorghum

This is a new project being developed by Mr Arnold. One hundred and two collections of *Sorghum* have been made during field trips to Natal and the north and north-eastern Transvaal. Thirty-two collections from elsewhere in Africa have been obtained from the Department's seed bank and have been grown. Herbarium collections, seed (when available) and photographs have been taken to form the basis of a study of the origin and evolution of *Sorghum* in the sub-continent. Chromosome counts have begun.

Previous accounts of *Sorghum* have largely ignored South African material and already Mr Arnold has found several variants that were thought not to exist in South Africa.

The origin and evolution of Pennisetum

A second new project on an indigenous food crop is that on *Pennisetum*. It is being carried out by Miss K. J. Duggan. Ninety-two collections of *Pennisetum* were made in Natal and the Transvaal, and seed of 25 collections from elsewhere in Africa was grown, to provide material for a study of the origin and evolution of this group. This material already includes a very wide variety of 'wild', cultivated and intermediate plants.

Citrullus studies

Twenty-three collections of *Citrullus* (Watermelons) were added, mainly by Mr Arnold and Miss Duggan, to our already large collection. Recordings of variations in fruit and seed characteristics of *Citrullus* were made and will be used later for a study of the origin and evolution of this crop plant.

Conservation of germ plasm

This project, quiescent for some time, has benefited by material gathered in the course of other studies.

Seventy-eight collections of *Sorghum* seed and 46 collections of *Pennisetum* seed were contributed to this project which aims to conserve germ plasm of primitive varieties of crop plants. Other collections included 27 of *Citrullus* and related taxa, 6 of *Lagenaria* and 10 miscellaneous. Information relating to rare and endangered indigenous species was compiled by Mrs J. B. Hoffmann who combines this work with her other duties as Public Relations Officer.

Ethnobotany

Miss C. A. Liengme has commenced an intensive investigation of wood utilization by the Tsonga of Gazankulu. Collections have been made in the study area to enable firewood and wood used for building to be identified by gross morphological features. The quantity and kinds of wood used for different purposes will be monitored over several seasons, and the effect of timber gathering will be analysed.

Miss Liengme has also continued gathering records of tribal plant uses for the sub-continent and this will continue as a long-term project.

Cover and barrier plants

Another new project, a survey of indigenous plants of potential as barriers or ground covers has been initiated by Miss L. Henderson. Plants are being collected, grown and screened for use as hedges, binders, windbreaks, etc., in the various climatic regions of South Africa. Over 100 plants with potential have been identified and over 50 have been collected.

Tree distribution in the Transvaal

Dr J. Anderson's survey of the distribution of woody plants in the Transvaal has had to take second place to his palaeoflora work but good progress was made nevertheless. Two hundred and ten field listings of woody plants have become available during the report year. Most of these were provided by co-operating researchers from outside the Department who helped fill distribution gaps in the Waterberg and in Venda. One thousand nine hundred of the approximately 7 000 1/16th degree squares occurring in the Transvaal have now been

sampled. The field work is scheduled for completion next year.

Information service

Mrs D. M. C. Fourie, our Scientific Information Officer, handled 261 requests for information about economic plants and their utilization or control. These included about 120 identifications. Particular interest was shown in oil and rubber producing plants such as *Simmondsia* (jojoba) and *Parthenium* (guayule).

Over two thousand visitors including delegates to the International Rose Convention, members of the Wild Life and Tree Societies and many scholars were taken on tours of the Institute. In this aspect of her work Mrs Fourie received the assistance of Mrs Hoffmann, our new Public Relations Officer.

National weed list

The first draft of the National Weed List which contained the names of 700 species, has been expanded as a result of suggestions received from many correspondents. Mr A. A. Balsinhas is responsible for the expanded list that now includes approximately 1 500 species and 4 500 common names. The identities of exotic species have been checked at Kew by Mr C. H. Stirton and the listed species are being classified by Miss V. M. Lorentz according to whether they are indigenous or exotic; and according to the situations where they cause problems and the kind of problems caused. The second draft of the list containing this information will be ready by the end of the year.

Woody invaders

The intensive survey of exotic woody invaders in the central Transvaal, which was completed last year by Miss Duggan and Miss Henderson, has been analysed and the minimum effective sampling level has been calculated. Sampling at this level is now being expanded to cover the rest of the Transvaal.

The rate of spread of some invader species has been calculated from aerial photographs. For example, one large infestation of *Acacia dealbata* (silver wattle) has increased its area by 20% in 8 years. This work is continuing.

Book on plant invaders

The book 'Plant invaders: beautiful but dangerous' compiled and edited by Mr C. H. Stirton for the Cape Department of Nature and Environmental Conservation has proved such a success that it is being re-printed.

Lantana camara

Mr Stirton has completed his review of the voluminous international literature dealing with *Lantana*, has consulted herbarium material in Europe and has sorted out most of the nomenclatural problems of the *L. camara* complex.

Most of the cytogenetic work on the many variations occurring in South Africa has also been completed by Mrs W. G. Gaum. The morphological and genetic data must now be assessed and explained in terms of the evolutionary constraints operating on the important weed group.

Rubus

Many collections of weedy brambles (*Rubus* spp.) were made by staff of the Section, and Mrs Gaum

made a start on a study of the complex cytogenetics of the genus in South Africa. The occurrence of two species *R. niveus* (Java bramble) and *R. phoenicolasini* (wineberry), both with weedy potential, has been fully documented for the first time, in articles prepared by Mr Stirton.

Cyperaceae

Several papers dealing with convergent evolution, an infra-specific hybrid, and morphological variation within the genus *Ficinia* have been prepared by Mr Arnold. These studies are of particular significance as a number of species of *Ficinia* are regarded as forestry weeds in the Cape, and a good understanding of the genus is required.

Nassella tussock

Research on the germination, establishment, and distribution of the grass weed *Nassella tussock* in the winter-rainfall area is being continued by Mr G. Harding, who took over the project from Miss S. Bulley at the end of 1979. Prior to that Mr Harding completed his B.Sc. Hons degree whilst seconded to Natal University.

GARDEN SECTION

There were two major developments in the garden during 1979/80. Firstly, the garden was declared a national monument and a plaque was unveiled by Dr R. A. Dyer, a previous Director, on the 25th of October 1979 to commemorate the event. One of the benefits of national monument status will be protection of the terrain from expropriation for road-building and other purposes.

A second major development was the landscaping of the water garden, karoo and grassland areas. This landscaping which had long been planned, suddenly became a reality when large quantities of soil became available at an adjacent site. Contractors working on the new police stores were grateful to find a dumping area for about 35 000 cubic metres of soil, and also excavated dams for us in order to obtain shale for road building. This development was made possible by the quick thinking of Mr H. J. de Villiers and Mr T. A. Ankiewicz of the garden section. Six koppies were built and four dams and linking channels were excavated. In all we obtained material, labour and machine time to the value of about R100 000, in return for payment of R9 000. Understandably, other garden activities had to suffer in order to make the most of this windfall, and no perennial plants could be planted out in the nine months under review. However, progress was made in other areas. The excavation of the swamp forest area and the landscaping of savanna koppies were completed and the existing irrigation and roads systems were expanded.

The post of curator of the botanic garden has not been filled and the curator's duties continue to be divided between two acting curators, the technicians in charge of the nursery and garden sub-sections respectively. Mr D. S. Hardy continued in charge of the nursery, but health reasons caused Mr J. Erens to step down as technician in charge of the garden. His place was taken by Mr H. J. de Villiers, and Mr Erens moved to the nursery where he is responsible for the propagation of plants for display purposes.

There were 376 accessions to the garden's permanent scientific collections and 238 to the new category of temporary experimental collections, during the nine months under review. The main experimental

collections were of barrier plants, and of *Sorghum* and *Pennisetum* food plants.

Mrs B. C. de Wet and Mrs K. P. Clarke continued with the task of labelling and record keeping. Mrs de Wet was particularly active in the computerization of garden records. Amongst the benefits of computerization, are biome planting lists and directly typed garden labels on request. Computerization is

also assisting in keeping track of the recent surge of experimental plantings.

With so much development having taken place in 1979/80, we look forward to several years of consolidation, in building up and maintaining biome plantings, and in utilizing the material already available.

BOTANICAL RESEARCH INSTITUTE

Scientific, Technical and Administrative Staff (31st March 1980)

Director

B. de Winter, M.Sc., D.Sc. (Taxonomy of Poaceae, especially *Eragrostis*, and of *Hermannia*; plant geography)

Deputy Director

D. J. B. Killick, M.Sc., Ph.D., F.L.S. (General taxonomy and mountain ecology)

Assistant Director

D. Edwards, M.Sc., Ph.D. (Ecological methodology; aquatic plants, remote sensing and vegetation structure and physiognomy)

ADMINISTRATION

Administrative Officer...	D. F. M. Venter
Senior Administrative Assistant	Mrs G. E. Hussem, B.A.
Senior Administrative Assistant (Personnel)...	J. Conradie
Assistant Accountant....	A. Smith (Temporary)
Administrative Assistants	Mrs J. Rautenbach Mrs M. C. van Niekerk
Personal Secretary to Director	Mrs M. M. Loots
Senior Clerical Assistant.	Mrs T. Creffield (Registry)
Clerical Assistants.....	Mrs C. A. Bester Mrs J. S. A. Strydom (Personnel) Mrs I. J. Joubert* (Registry)
Receptionist.....	Mrs M. E. M. Venter
Typists	Mrs N. Miller* Mrs S. M. Thiarth* Mrs J. Gerke*
Technician: Assistant to Secretary-General: AETFAT	Mrs B. A. Momberg*

HERBARIUM SERVICE SECTION

Officer in Charge..... E. G. H. Oliver, M.Sc.

NATIONAL HERBARIUM, PRETORIA (PRE)

Chief Professional Officers..... E. G. H. Oliver, M.Sc. (Curator; Ericaceae)
Mrs E. van Hoepen, M.Sc. (Assistant Curator; supervision of identifications and enquiries)

Technical Assistant.....	Vacant
<i>Wing A</i> (Cryptogams—Monocotyledons)	
Chief Professional Officer	Mrs E. van Hoepen
Senior Professional Officer	Miss C. Reid, B.Sc. Hons
Technician	Miss L. Smook, B.Sc. (Poaceae)
Technical Assistant	Mrs A. M. Fourie*
<i>Wing B</i> (Piperaceae—Oxalidaceae)	
Senior Professional Officer	G. Germishuizen, B.Sc. Hons (Polygonaceae)
Professional Officer.....	Vacant
Technical Assistant.....	Mrs I. R. Leistner*
<i>Wing C</i> (Linaceae—Asclepiadaceae)	
Chief Professional Officer	Miss E. Retief, M.Sc. (Campanulaceae)
Professional Officer.....	P. P. J. Herman, B.Sc. Hons
Technician.....	Mrs M. J. A. W. Crosby, B.Sc.*
Technical Assistants.....	Mrs J. I. M. Grobler* C. Hildyard, B.Sc. (Elec. Eng.) (part-time)
<i>Wing D</i> (Convolvulaceae—Asteraceae)	
Chief Professional Officer	Miss W. G. Welman, M.Sc.
Professional Officer.....	Mrs S. J. Smithies, M.Sc.
Technical Assistant.....	Mrs K. A. Kleynhans*
<i>Cryptogamic Herbarium</i>	
Senior Professional Officer	R. E. Magill, M.S., Ph.D. (Musci)
Professional Officer.....	F. A. Brusse, B.Sc. Hons (Lichens)
Technical Assistants.....	Mrs L. R. Filter* Mrs P.W. van der Helde J. van Rooy (Musci)

Services

Technical Assistants.....	Mrs I. Ebersohn (Herbarium records, loans and exchanges, parcels, etc.) Mrs S. M. Perold, B.Sc. (S.E.M. and laboratory work) Mrs G. L. Radmacher (Phytogeography and data bank) Mrs A. M. Verhoef
Typist	

Photographic Room

Photographer	Mrs A. J. Romanowski
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*Half-day

NATAL HERBARIUM, DURBAN (NH)

Senior Professional Officer	P. C. V. du Toit, M.Sc. (Curator; Poaceae, especially <i>Pentstemon</i> , and general identifications, until 1980/06/30)
Professional Officer	B. D. Schrire, B.Sc. Hons (Curator from 1980/08/01)
Technician	Mrs B. J. Pienaar, B.Sc.*
Technical Assistant	Mrs L. Nichols

	Mrs A. A. Obermeyer-Mauve, M.Sc. (Taxonomy, especially Monocotyledons)
	C. H. Stirton, M.Sc. (Liaison Officer, Kew; taxonomy, especially Fabaceae and weeds)
Professional Officer	Miss K. L. Immelman, M.Sc. (Taxonomy)
Senior Technician	Mrs H. M. Anderson, Ph.D. (Palaeoflora)
Graphic Artist	Mrs R. C. Holcroft
Technical Assistants	Mrs C. F. Fourie
	Miss N. van der Meulen

ALBANY MUSEUM HERBARIUM, GRAHAMSTOWN (GRA)

Senior Professional Officer	Mrs E. Brink, B.Sc. (Curator; general identifications)
Technical Assistants	Vacant
	Miss G. V. Britten*

GOVERNMENT HERBARIUM, STELLENBOSCH (STE)

Senior Professional Officer	Miss L. Hugo, M.Sc. (Curator; general identifications)
Professional Officer	Miss M. Schonken, B.Sc. Hons
Technician	D. A. Davies, B.Sc.
Technical Assistant	Mrs R. Wikner
Clerical Assistant	Miss E. N. Pare

FLORA RESEARCH SECTION

Officer in Charge	O. A. Leistner, M.Sc., D.Sc., F.L.S.
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FLORA OF SOUTHERN AFRICA TEAM

Chief Professional Officer	O. A. Leistner, M.Sc., D.Sc., F.L.S. (Taxonomy, especially Malvaceae)
Senior Professional Officers	J. M. Anderson, Ph.D. (Palaeo-ethnobotany, palaeoflora, plant geography)
	L. E. W. Codd, M.Sc., D.Sc. (Taxonomy, especially Lamiales; history of plant collecting)
	Mrs G. E. Gibbs Russell, B.S., Ph.D. (Taxonomy, especially grasses)
	H. F. Glen, M.Sc., Ph.D, F.L.S. (Numerical taxonomy, Mesembryanthemaceae)

PLANT STRUCTURE AND FUNCTION SECTION

Chief Professional Officer	R. P. Ellis, M.Sc. (Anatomy of southern African grasses)
Professional Officer (Anatomy)	Miss R. Manders, B.Sc. Hons (Grazing studies)
Professional Officer (Cytogenetics)	Vacant
Technical Assistant	Vacant

ECOLOGY SECTION

Officer in Charge	J. C. Scheepers, M.Sc., D.Sc.
Chief Professional Officers	J. C. Scheepers, M.Sc., D.Sc. (Vegetation ecology, especially of forest/woodland/savanna/grassland relationships; conservation and land-use planning; phytogeography)
	H. C. Taylor, M.Sc. (O/C Botanical Research Unit, Stellenbosch; mountain fynbos and forest ecology; Braun-Blanquet approach and techniques; conservation)
	C. Boucher, M.Sc. (Lowland fynbos ecology and phytosociology; conservation and land-use planning; Braun-Blanquet approach and techniques)
	P. J. Weisser, Ph.D. (Reedswamp ecology; ecological planning and environmental impact studies; Zululand coast dune vegetation; conservation)

Senior Professional Officers.....

F. Musil, M.Sc.
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R. H. Westfall, B.Sc.
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Miss A. J. Naudé, B.Sc. (Ecological literature, air photos and maps)

Mrs M. Engelbrecht, B.A. Hons (Fine Arts) (Draughtmanship and cartography; artwork, layout and design)

DATA PROCESSING AND ECOSYSTEM STUDIES SECTION

Officer in Charge..... J. W. Morris, M.Sc., Ph.D.

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Miss V. M. Lorentz, B.Sc. (Weed research)

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PRETORIA BOTANICAL GARDEN

Curator Vacant

Acting Curator (garden).. H. J. de Villiers

Acting Curator (nursery). D. S. Hardy

First Research Technicians D. S. Hardy (Nursery supervision, succulents and orchids)
H. J. de Villiers, NTC III (Hort.), Dipl. Rec. P.A. (Development of savanna biome)

Senior Research Technicians J. Erens (Propagation of display material)
T. A. Ankiewicz, Dip. For. (Administration, stores and purchases, and development of coastal forest biome)

Research Technician..... Mrs M. C. Innes, Nat. Dip. Tech. (Hort.), (Nursery and devel-

Technical Assistants..... opment of fynbos biome)
Mrs B. C. de Wet*,
B.A. (Garden records)
Mrs K. P. Clarke
(Garden records)

Learner Technicians..... Miss H. D. Eloff
Miss Y. Mennin
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PUBLICATIONS BY THE STAFF (1 July, 1979–31 March, 1980)

BOUCHER, C., 1980. Vegetation under stress. An introduction to a study of the western Cape coastal foreland vegetation. *Veld & Flora* 66: 14–16.

CAMPBELL, B. M., MCKENZIE, B. & MOLL, E. J., 1979. Should there be more tree vegetation in the Mediterranean climatic region of South Africa? *Jl S. Afr. Bot.* 45: 453–457.

CODD, L. E., 1979. The story of the Barberton Daisy, *Gerbera jamesonii*. *Veld & Flora* 65: 144–145.

GUNN, M. D., & CODD, L. E., 1979. Plant collecting pioneers in the Barberton area. *Veld & Flora* 65: 98–101.

DYER, R. A., 1980. *Brachystelma*, *Ceropegia* and *Riocrexia*. *Flora sth. Afr.* 27,4: 1–91.

KILLICK, D. J. B., 1979. African mountain heaths. In R. L. Specht, *Heathlands and related shrublands of the world. A Descriptive studies*. Amsterdam: Elsevier, 97–116.

MORRIS, J. W. & GLEN, H. F., 1979. PRÉCIS, the National Herbarium of South Africa (PRE Computerized Information System). In G. Kunkel, *Taxonomic aspects of African economic botany. (Proceedings of the IX Plenary Meeting of AETFAT)*. 206. Las Palmas: AETFAT.

ROSS, J. H., 1979. A conspectus of the African *Acacia* species. *Mem. bot. surv. S. Afr.* No. 44, 1–155.

RUTHERFORD, M. C., 1979. Plant-based techniques for determining available browse and browse utilization: A review. *Bot. Rev.* 45: 203–228.

RUTHERFORD, M. C., 1980. Annual plant production — precipitation relations in arid and semi-arid regions. *S. Afr. J. Sci.* 76: 53–56.

STIRTON, C. H., 1979. Taxonomic problems associated with invasive alien trees & shrubs in South Africa. In G. Kunkel, *Taxonomic aspects of African economic botany. (Proceedings of the IX Plenary Meeting of AETFAT)*. 218–219. Las Palmas: AETFAT.

TAYLOR, H. C., 1979. Observations on the flora and phytogeography of Rooiberg, a dry fynbos mountain in the southern Cape Province, South Africa. *Phytocoenologia* 6: 524–531.

TAYLOR, H. C., 1979. Phytogeography. In J. Day, W. R. Siegfried, G. N. Louw & M. L. Jarman, *Fynbos ecology: A preliminary synthesis*. 70–81. Pretoria. South African National Scientific Programmes. Report No. 40.

WELLS, M. J., DUGGAN, K. J. & HENDERSON, L., 1980. Woody plant invaders of the Transvaal. In S. Neser & A. L. P. Cairns, *Proceedings of the Third National Weeds Conference of South Africa*. 11–24. Cape Town: Balkema.

WELLS, M. J., HARDING, G. B., BALSINHAS, A. & VAN GASS, B., 1980. A preliminary experiment of sampling agronomic weeds for a national survey. In S. Neser & A. L. P. Cairns, *Proceedings of the Third National Weeds Conference of South Africa*. 62–65. Cape Town: Balkema.

WERGER, M. J. A., MORRIS, J. W. & LOUPPEN, J. M. W., 1979. Vegetation- soil relationships in the southern Kalahari. *Doc. Phytosociol. (Lille)* 4: 967–981.

WIENS, D. & TÖLKEN, H. R., 1979. Loranaceae and Viscaceae. *Flora sth. Afr.* 10,1: 1–59.

Book Reviews

HEATHLANDS AND RELATED SHRUBLANDS: DESCRIPTIVE STUDIES (Ecosystems of the World, Vol. 9A) edited by R. L. SPECHT. Amsterdam: Elsevier Publishing Company. 1979. Pp. xiv + 497. 138 figures, 81 tables. Price R98.

Although this book is numbered 9A in Elsevier's series, 'Ecosystems of the World', it is among the earliest of the thirty volumes to be published. 'Heathlands and Related Shrublands' is to appear in two volumes of which only the first has been published and is reviewed here. 'Part A: Descriptive Studies' describes the extent, variation and ecology of heathlands and related shrublands throughout the world. In Part B the phenological, morphological and physiological characteristics of the heathland ecosystems will be dealt with. Volume 9A is an imposing book. The text is set in clear, double-column print and over half of its 497 pages consists of tables, diagrams, appendices, references and photographs. In 23 chapters, 30 authors from eight countries describe the heathlands of the various continents and some adjacent islands. The presentations vary in length from a two-page compilation to a comprehensive treatment comprising 83 pages.

In the introductory chapter, 'Heathlands and related shrublands of the world', Specht traces the origin of heathland communities from the pre-Angiospermous flora of Gondwanaland, and defines the heathland concept floristically and structurally. In distinguishing between the terms 'heath' for a member of the heath families which he lists in the orders Celastrales, Ericales and Santalales, 'heathland' for the vegetation type and 'heathland species' for the many diverse species and families which together comprise the 'heathland' community, Specht lays the foundation of uniformity necessary for the varied treatments that follow.

The next three chapters are of great interest to South African ecologists. Kruger's 'South African heathlands' is the most comprehensive account of the fynbos ecosystem as yet published. His explicit summary of environmental factors is followed by a synusial description of vegetation which, though unusual, is most effective in relating the life cycles of fynbos plants to the dynamics of regeneration after fire. His account of vegetation zones and community types is amplified by tables of original data on structure and floristics and is illustrated by several good photographs. Bigalke's account of aspects of vertebrate life in fynbos reveals the region to be less distinct faunistically than it is floristically. In the chapter on African mountain heathlands, which are concentrated mainly along the eastern mountains and highlands, Killick ably summarizes the information available from literature and cites his own researches on heathland in the Drakensberg. The floristic affinity with fynbos is evident in the high proportion of fynbos taxa throughout the African mountains. The good photographs show that the physiognomy is also comparable; Fig. 4.3 of the Ericaceous Belt on Mount Kilimanjaro is especially striking in its similarity to the Dwarfsberg communities in Kruger's Fig. 2.12.

A brief chapter by Page covers the Macaronesian heathlands. These are floristically poor but vegetationally luxuriant, sometimes reaching up to 10 m or more in height. They occur in a cool temperate climate with high precipitation and show greater affinity with some European heathy shrublands than with the heathlands of the African mainland. For this reason the chapter could have been better placed next to the one on European heathlands.

The next five chapters deal with Australian heathland ecosystems. Specht's excellent account of the heathlands of east and central Australia is supplemented by two appendices of tables which can be readily compared with Kruger's fynbos data. In structure, life forms, leaf characters and general biology, including fire-survival strategy, Australian heathlands are strikingly similar to South African fynbos, with one important difference: the frequent occurrence in Australia of an overstorey of tall shrubs and trees. The Australian heath flora, like the Capensis flora in South Africa, is an ancient one, rich in species, that has evolved in a changing climate from pre-Angiospermous Gondwana origins. In both continents, heathlands are confined to nutrient-poor soils and in both, fire and a high seasonal moisture stress are the chief ecological factors that mould the physiognomy of the vegetation. The Australian heathland, however, occurs over a much wider range of climates than fynbos, and many of the widespread species, unlike those of fynbos, show great plasticity in growth form, 'often the same taxon ranging in habit from a dwarf shrub to a tree 10 to 30 m in height' (p. 144). In Chapter 7, George, Hopkins and Marchant survey the heathlands of Western Australia. The greater part of this chapter reports the original results of a study of species richness and biogeography by Marchant and Hopkins. The vegetational and ecological aspects are presented in tabular form which, however, seems to me too compressed to take the place of a concise textual account. Of special interest are the 'isoflor' maps that show a southwestern concentration of taxa similar to that found in the fynbos flora. The last three chapters of this section are rather detailed accounts

of special investigations into the faunal components of some Australian heathlands.

The vegetation of the island complexes close to the Australian mainland is next described. The 'maquis' of New Caledonia, a sclerophyllous vegetation on oligotrophic soils, is described in a brief compilation by Specht. This is followed by a stimulating account of heathlands and shrublands of *Malesia* by Specht and Womersley. As a result of the complex splitting apart and later merging of Gondwanan tectonic plates, there are major discontinuities in the modern floras of these islands. Heath species are found as dwarf shrubs above timberline on mountains and at low altitudes on infertile coastal sands. Very interesting is the fact that in dipterocarp rain forests on fertile soils, typical heathland species with coriaceous leaves and lignotubers occur as epiphytes in an oligotrophic environment in the sunlit branches of the tallest trees. Some of these epiphytes become terrestrial at high altitudes where they form a subalpine heathland on infertile soils. The authors conclude that 'the emergence of "heath" species from the primary tropical and lower montane rain forest appears to hold clues to the development of heathland on oligotrophic soils throughout the world' (p. 332). Each of the four authors to Chapter 13 on the heathlands of New Zealand (Burrow, McQueen, Esler and Wardle) has, either singly or in collaboration, produced at least one of the vegetation accounts of the eight heathland regions described. For a country where 'the study of heathlands is not far advanced', the authors have succeeded in summarizing existing information sufficiently to enable comparisons to be made with heathlands elsewhere.

Three British authors, Gimingham, Chapman and Webb, have written the chapter on European heathlands. The authors' non-regional treatment gives a well co-ordinated synoptic picture; good maps, diagrams and photographs aptly illustrate the well written text. (Fig. 14.7 showing two complete annual increments on a twig of *Calluna vulgaris* is the only close-up photograph of a heathland plant in the whole book). The temperate oceanic climate of the European heathland region is quite different from the Mediterranean and sub-Mediterranean climates of the fynbos biome. Nevertheless, the similarities between European heathland and Cape fynbos make this chapter of particular interest to South African readers. Lowland heathland occurs along the Atlantic fringe of the European continent from Scandinavia to northern Spain; elsewhere in Europe related vegetation types are found on mountains. Fynbos has a similar pattern of distribution. European heathlands are usually floristically poor, but their geographical and climatic ranges are so wide that these heathlands, like fynbos, 'provide an excellent example of continuous variation in floristic composition'. Continuum studies and Braun-Blanquet classification have both contributed conspicuously to an understanding of regional variation in heathland composition; both treatments might well be equally successful in fynbos. *Calluna vulgaris* is often the dominant species in European heathlands. The cyclical dynamic process in *Calluna* heath has its counterpart in fynbos succession. The biology and ecology of *Calluna*, including the processes involved in litter conversion and nutrient cycling, have been closely studied in Europe, especially with reference to the maintenance of *Calluna* heathland by fire. The chapter closes with a fascinating account of the role of fauna in maintaining the heathland ecosystems. The detailed knowledge accumulated, especially regarding the invertebrate fauna, makes one only too aware of our shortcomings in this sphere of fynbos research.

The vegetation of extreme climates is treated in the two following chapters. The vegetation of the Arctic heathlands beyond the climatic limit of trees, described in Chapter 15 by Bliss, has much in common with the heathlands of the north temperate zone treated in the preceding chapter. The species grow on shallow soils; their nutrient availability and dry matter production are low, but even in the tundra, fires occur and temporarily increase the content of nitrogen, phosphorus and potassium in plant regrowth. Specht's short compilation in Chapter 16 shows that the Japanese alpine communities are essentially similar to the arctic heathlands in the mountains of the Chukchi Peninsula of Far Eastern Siberia described by Bliss.

Four of the remaining chapters cover North America and three South America. To the North American the word 'heath' means simply a plant that is a member of the family Ericaceae or the order Ericales. The term heath or heathland is applied much less to plant communities, and it is evident from the text that the North American 'heathland' is different from most of the vegetation described in previous chapters. True heathland, as defined by Specht in Chapter 1, consists of shrubs not exceeding 2 m in height, in the Ericales and other orders, with leaves that are mostly either 'ericoid' (narrow-leptophyll and grooved below) or at least very small, narrow and sclerophyllous. Apparently this sort of vegetation does not occur significantly in North America except in Mediterranean-type shrublands which will be dealt with in a later volume of this series. The North American shrublands described in the present book are preponderantly broad-sclerophyll and usually taller than 2 m. In some of the communities, if fire is excluded, succession proceeds to forest; in others, the shrubland forms a

fire-maintained understorey to woodland or open-forest. These communities are the 'related shrublands' referred to in the title of the book. The only features common to true heathland and related shrubland seem to be the relatively low stature of the vegetation and its sclerophyllous, oligotrophic soils and the role of fire in community dynamics. Whereas true heathlands form extensive and distinct regional biomes in climates which, by and large, are unsuitable for forest growth, the shrublands described for North America are confined to 'islands' within a forest climate, where a particular habitat factor, usually edaphic and often re-inforced by fire, restricts succession to a pre-climax stage. Thus, to the South African reader seeking knowledge of world equivalents to fynbos — a heathland *sensu stricto* — the chapters on North American shrublands, good as they are, may be confusing.

Most of the above observations apply equally to the South American vegetation described in the final chapters. The muri and savannah vegetation of the Guianas described by Cooper, and the caatingas and campinas of the Amazonas, by Klinge and Medina, are certainly shrublands. By contrast, Moore's account of the southern oceanic wet-heathlands of Tierra del Fuego, southern Patagonia and islands in the South Atlantic shows that they are clearly true heathlands, probably similar to the heathlands at equivalent latitudes in northern Europe. They are dominated by *Empetrum rubrum*, an ericoid-leaved low shrub in the Celastrales which is allied to the Ericales. Their structure, growth form and floristic composition are clearly summarized in Table 23.2, a form of presentation similar to Specht's tables for the heathlands of eastern and central Australia and to Kruger's for fynbos. Comparison of these tables makes their physiognomic similarity immediately clear.

In summary, it seems that the rather different structural categories, true heathland and related shrubland, were necessarily combined in one treatment because they sometimes intermix or interdigitate. I feel, though, that their respective characteristics needed clarifying by explicit definition and by consistent use of photographs and standardized tables to illustrate each text. That said, the editor has shown great skill in bringing so many different regional accounts together in one volume. South African ecologists will find many of the chapters, especially those on Australian and European heathlands, of great value because the information may be adapted and applied in practical fynbos management or may suggest lines of future basic research. Heathlands are so widely and patchily scattered throughout the world, in such a variety of climates, that their essential unity has not hitherto been recognized. This book, which provides the first world-wide treatment of heathland ecosystems, will surely be a standard reference work for many years, and even at its price of nearly R100 must find a place in the library of every institution where vegetation is studied.

H. C. TAYLOR

THE STUDY OF VEGETATION edited by M. J. A. WERGER. *The Hague: Dr W. Junk bv.* 1979. Pp. xi + 316, 73 figures and 9 tables. Price \$59.50.

This small book was compiled to celebrate the one-hundredth meeting of the Commission for the Study of Vegetation of the Royal Botanical Society of the Netherlands and was intended to be a review of the developments in the various branches of vegetation science with special reference to Dutch contributions. Although it includes chapters on most aspects of vegetation science, the title is perhaps a little pretentious, or at least misleading, in that coverage is parochial as far as choice of authors and the emphasis of individual chapters are concerned. The contents of the book are not being criticized here as they meet the aim, as elaborated above. My criticism is directed at the title, from which one may, at first glance, expect more than the book actually offers.

Dutch contributions to vegetation science through the years have been far from insignificant and it is gratifying to see chapters in this book by such respected figures as V. Westhoff and J. J. Barkman, amongst others. Westhoff, who discusses the history, present state and future of phytosociology in the Netherlands, was an excellent choice for the review as he has had decades of first-hand experience with the subject. Three of the eleven future developmental trends in phytosociology which he lists are its use as integrator of several aspects of nature conservation research, the carrying out of basic ecological surveys and vegetation dynamic studies in Third World countries and, thirdly, the major impact of numerical data processing in the discipline. Vegetation texture and structure are discussed in the contribution by Barkman. He defines texture as the qualitative and quantitative composition of the vegetation as to different morphological elements, whereas structure is concerned with the horizontal and vertical spatial arrangement of these elements. In a clear and concise way he reviews the extant systems of classification on the basis of texture and structure, points out their shortcomings and compares them with

selected floristic systems. He concludes with a brief account of his system which makes use of many parameters already known in the literature as well as growth forms that he has defined. It appears to be a detailed, although rather complicated, system and we look forward to its description by Barkman *in extenso* in the near future.

A chapter on multivariate methods in phytosociology, with reference to the Netherlands was contributed by E. van der Maarel. The long sections on data transformations, resemblance functions, classification and ordination add little that is new except to place Dutch contributions to quantitative ecology, and the author's contributions in particular, in a world perspective. Van der Maarel quotes three recently-published excellent reviews and his repetition here of the same material appears largely unnecessary. The review is complete as far as Dutch research is concerned and it is interesting to see how much of relevance in the field of multivariate methods has been either carried out or directed by the author. The two other Dutch researchers who, in my opinion, stand out in this field and whose work is discussed in the review are W. G. Beaufort and Pauline Hogeweg. Unfortunately, the subject is advancing at such a rate that this chapter is already out of date with respect to certain methods—it cannot be otherwise in a developing field such as this is.

There are a total of eight review papers in the book. Apart from those already mentioned, the subjects of autecology (W. H. van Dobben), population biology (S. J. ten Borg), competition (J. P. van den Bergh), palynology (C. R. Janssen) and nature conservation (P. A. Bakker) receive adequate treatment in this clear statement on the status of Dutch plant ecology in the broadest sense. Possibly the most striking feature about the book as a whole, is the great difference between problems which merit attention in a small, highly developed and densely populated country like the Netherlands and those of countries such as ours. While we are still deeply involved with regional surveys and the autecology of dominant species, they are now investigating subtle interactions between components of vegetation, dispersal mechanisms in detail and the biology of individual populations. The biome studies being mooted at present should contribute materially towards greater depth coming to our vegetation science. The editor and the Commission for the Study of Vegetation are to be congratulated on the production of a valuable synthesis on which the future of vegetation science in the Netherlands can be built.

J. W. MORRIS

FLOWERING TREES IN SUBTROPICAL GARDENS by GÜNTHER KUNKEL. *The Hague: Dr W. Junk bv.* 1978. Pp. 346, line drawings 139, photographs 6. Price US \$36.85.

At the start of this book Günther Kunkel apologizes for being what I can only describe as a 'soul scientist', for having indulged himself, including some species and leaving others out, for having enjoyed his work and made no secret of it. For this there is surely no need to apologize. His enthusiasm and delight in his subject, together with the fine illustrative work of Mary Anne Kunkel, lift this work above the mundane. If an apology is needed, it is for the overly ambitious and misleading title of the book. The plants dealt with are flowering trees, the gardens of the Canary Islands, where they occur, are subtropical and many of the species are widely cultivated in other subtropical areas, but the same could be said of South African or Australian gardens, all of which have different, if overlapping, cultivated floras.

This book has its origin in a previous (1969) publication, volume 1, of 'Arboles Exóticos' i.e. exotic trees of the Canary Islands, and that is what it still is—and a very useful tool for botanist, horticulturalist and layman alike. It deals with 150 species from 98 genera and 48 families. No palms or large monocots have been included. Each species is described and illustrated. The descriptions are both useful and readable (a rare achievement). There are also brief notes on propagation, cultivation, growth requirements and uses, with references for further reading. General sections include an index, bibliography, a list of English and American common names, a list of Spanish and Canarian common names, a list of trees native to the Canary Islands, and a key to the identification of the exotic species treated in the book.

The illustrations are generally superb — both in the way they portray their subjects, and in their technical execution. Fig. 1, *Magnolia grandiflora* is a masterpiece, down to the leathery feel of the leaves. However, a few of the illustrations do not do justice to the artist, being 'scratchy' e.g. Fig. 30, *Ficus virens*; over-inked e.g. Fig. 34, *Casuarina* spp.; or not sufficiently representative of the subject e.g. Fig. 90, *Tipuana tipu* and Fig. 117, *Melicoccus bijugatus*. The photographs are poor, but fortunately this does not detract from the general appeal of the book.

For anyone interested in the Canarian flora, I can recommend this book with few reservations. For those who consider using it under South African conditions, the reservations are greater. It

would, for example, be extremely misleading to try to identify trees cultivated in South Africa using a key designed for the Canary Islands, e.g. our *Celtis africana* and *Erythrina lysistemon* (which are not included) would key out as *Celtis australis* and *Erythrina caffra*, and only an expert would pick out the difference from the illustrations. If used with discretion, however, this book can be a distinctly useful means of identification and reference source. Of the species treated about 44% are commonly cultivated here, 20% are reasonably common, 16% occasional, and 20% are rare, seldom or never seen. It is perhaps in this last category that this work can be most useful in South Africa, for it brings to mind a number of potentially useful garden subjects.

M. J. WELLS

MEDICINAL PLANTS OF WEST AFRICA by EDWARD S. AYENSU. *Algonac: Reference Publications*. 1978. Pp 330, 77 black and white photographs and 51 line drawings. Price \$29.95.

This book deals with 187 plant species that have been used for medicinal purposes by the peoples of 'West Africa'. I can find no delimitation of the area included other than a map inside the cover that shows an area roughly bounded by the northern tip of Cameroon, Nigeria and Niger in the east, and including the western bulge of Africa as far north as the northern tip of Mauritania in the west. Nor can I find a firm basis for the inclusion of species, other than a reference in Prof. Schultes's foreword to the fact that of the multitude of drug plants occurring in West Africa, Dr Ayensu has chosen 'a frequently encountered part of the total'. Therefore 'Medicinal Plants of West Africa' cannot be regarded as a comprehensive reference work to plant medicinal uses in a specific area or flora.

The author states, 'The aim of this publication is to bring to the attention of professional specialists, pharmacologists, biochemists, health administrators and members of W. H. O. the botanical characteristics of medicinal plants that have been used in treating various ailments by traditional medical practitioners over the years . . . and it is hoped . . . will supply the necessary ethos to spur the medical community desirous of establishing the linkage between traditional and modern medicine'. As such it seems to be a plea not so much for scientific evaluation of traditional medicines (which has been well under way for the past century) as for a package acceptance of the role of traditional medicine.

The text on each plant has been handled systematically. Common names are classified according to country (but not tribe), and uses are classified according to the part of the plant used (with some observations on method of application e.g. 'enema'). The amount of text per species varies from two lines on *Pteris togoensis* to more than three pages on *Ricinus communis*, and is well referenced throughout. The book includes a useful glossary to medical terms; a bibliography of 61 publications; a species index; and, most useful of all, a medicinal index with plants classified according to their uses. The line drawings are good, but the photographs of herbarium sheets although recognizable are unacceptably fuzzy and lacking in contrast and detail.

A comparison of this book with J. O. Kokwaro's 'Medicinal Plants of East Africa' is inevitable: both are recent publications by researchers who have grown up in the regions concerned, the titles are similar and even the covers both sport *Erythrina* — yet there are many differences between the two books. Ayensu's treatment is the better illustrated and referenced, but the text is more or less limited to a literature survey and deals with relatively few species and is almost surgical in style and in the exclusion of tribal references (which could have added much of interest and value). Kokwaro's work on the other hand, is far more comprehensive (including over 1 300 species), reads well, is full of new material and tribal references and includes (in addition to plant and medicinal indexes) a useful vernacular index — but the text is usually limited to a few lines on each species, includes only 15 literature references and is only very sparsely illustrated. A combination of the two approaches for both East and West Africa would have been magnificent.

As it stands, South African botanists' main interest in 'Medicinal Plants of West Africa' will be the overlaps with our own flora and its uses. There are many such overlaps at both species and generic level, and for this reason alone, Dr Ayensu's book is an essential tool for economic botanists in South Africa.

M. J. WELLS

RHODESIAN WILD FLOWERS. Illustrations by MARGARET H. TREDGOLD. Text by H. M. BIEGEL. Thomas Meikle Series No. 4. Trustees of the National Museums and Monuments of Rhodesia. 1979. Pp. xvi + 77, 39 black and white drawings and 39 colour plates. Price Z\$10.00.

This book is the successor to the one of the same title by R. A. S. Martineau and Margaret H. Phear published as the first in this series as long ago as 1953. In the first 'edition' almost all of the illustrations were made from pressed specimens. This 'edition' has 18 full colour illustrations made from living plants by Lady Tredgold (Margaret Phear), wife of a former Governor of Southern Rhodesia. There is a brief foreword by R. A. S. Martineau. The copy I have is soft-covered and a little larger than A4 size.

The first sentence of the text states that the book is for the layman. There is a brief introduction with an unusually varied content written by the artist and then a page of notes for users by H. M. Biegel of the National Herbarium, Salisbury, who compiled the text. Then comes the main part of the book with alternating text, which is interspersed with black and white line drawings, and four colour plates. The book begins with grasses and ends with composites thus following Engler's system. A total of 260 species is covered in the text by a short paragraph on each, giving the Latin, English and vernacular names, some diagnostic characters and habitat details, distribution, derivation of names and mention of related species. The illustrations depict 221 species in colour with up to nine per plate and 39 as black and white sketches strategically scattered throughout the text. The book ends with two pages noting characters as recognition aids to families and genera, a short glossary and indexes to botanical and common names. The colour plates are printed on a semi-gloss matt paper.

The book is an improvement on the first and is a welcome addition to the increasing literature covering the flora of the southern half of Africa in coloured illustrations. South Africa itself is becoming well endowed with such works, some alas of rather poor quality. Further north we have recent works such as that of Plowes & Drummond for Rhodesia (Zimbabwe) and Moriarty for Malawi. One could be critical of the occasional rather 'woolly' paintings that occur in the present book (cf. Plate 9). These lack clarity and give more of an impression of the species than an exact reproduction. On the whole the colour work, which has a style all of its own, is pleasing and is sufficient for identification. One would have expected the artist to erase her pencil signature under the pen signature as this spoils a number of the plates. The text is very readable and will, I am sure, appeal to the layman.

I have said in a previous review that a reviewer is invariably drawn into noting and commenting on errors and the general production. The nightmare of any author is the way errors creep into a book during typing and printing. This book has its share of these gremlins. Two of the text figs (2 & 39) have their numbers missing, spelling mistakes are fortunately few, e.g. *rhmannii* for *rehmannii* on p.3, *C. bulbispermum* for *bulbispermum* on p.9, one pair of leaflet on p.30. One or two botanical points need some mention. *Gladiolus natalensis* is used instead of *G. dalenii*. Only ± 450 species are ascribed to the genus *Erica* in the winter-rainfall area of the Cape where the true figure is nearer 600! Under *Lapeirousia* the 'tubers' are noted as being edible when later on corns are correctly described. There is a curious inconsistency in the use of family names. In the text one finds the old familiar names like Gramineae, Leguminosae, Labiatae, Umbelliferae and Compositae, but also the modern Clusiaceae (Guttiferae).

There is only one real criticism of the work and that is the cross-referencing between the drawings and the text which will be exasperating at times for the layman. The plate and figure numbers are hidden in the text and are not at all conspicuous. One has to be sharp-witted about sorting out the plates and figures, especially as they run close on each other. Matters would have been so much better if Plate 7: 1 etc. or Fig. 23 had been strategically placed before each species name. Take, for example, the text figure on page 30 where there is no name given and the reference is hidden in the text under *Zornia glochidiata*.

This book appeared within three years of the work *Wild Flowers of Rhodesia* by D. C. H. Plowes & R. B. Drummond in which 193 colour photographs depict 150 species. The styles of the two books are completely different, but essentially they have one thing in common — to excite and interest the layman in the wealth of the Zimbabwean flora. Both should go a long way towards this objective and both should be possessed and used by all flower enthusiasts to whom I would strongly recommend this latest book. At its price it is good value.

E. G. H. OLIVER

A FIELD GUIDE TO THE NATAL DRakensBERG by PAT IRWIN, JOHN AKHURST & DAVID IRWIN. *Durban: Natal Branch of the Wildlife Society of Southern Africa*. 1980. Pp. 249, 47 colour photographs, numerous line drawings and 10 maps. Price R4.50.

Mountaineers, climbers, hikers, wild life enthusiasts and 'city slickers' will all welcome this field guide to the Natal Drakensberg, the first compact guide to be published on this subject. The guide covers almost every aspect of the Drakensberg scene, for example archaeology, early history, climate, weather, geology, geomor-

phology, soils, vegetation, birds, reptiles, amphibians, insects and mammals. However, it is only Chapter 6 on the vegetation that will be reviewed here.

The authors describe in fairly general terms the zonation of the vegetation and the main communities pointing out that the environment becomes more severe with increase of altitude and this is reflected in the growth forms of the plants. They also refer to the effect of aspect on vegetation.

Thirteen colour photographs show some of the more familiar Drakensberg plants, for example *Erica cerinthoides*, *Cussonia paniculata*, *Encephalartos ghellinckii*, *Buddleja salviifolia* and *Phygelius aequalis*.

Then follows a list of 47 trees and shrubs occurring in the Drakensberg with their common names. Finally, 70 'common flowers' are illustrated rather crudely but effectively in black and white. Unfortunately some of the plant names are incorrectly spelt, for example *Erica cerinthoides* instead of *E. cerinthoides*, *Harpechloa falx* instead of *Harpochloa falx* and *Watsonia densiforma* instead of *W. densiflora*. Worse than the misspellings is a glaring misidentification: the line drawing of '*Myrica serrata*' is really of *Myrsine africana*. The authors have not kept up with recent name changes: *Elyonurus argenteus* is now *Elionurus muticus* and *Haemanthus magnificus* is *Scadoxus puniceus*. Since 1978 *Buddleia salviifolia* must be spelt *Buddleja salviifolia*. It is a pity that the authors did not ask a botanist to check the chapter on vegetation.

In conclusion, Chapter 6 does give the reader a basic impression of the vegetation and flora of the Natal Drakensberg and, in a wide-ranging guide of this nature, this is surely all one can expect. The authors and the Natal Branch of the Wildlife Society of Southern Africa deserve congratulation for producing this useful and long overdue guide to the Natal Drakensberg.

D. J. B. KILLICK

ATLAS OF THE NETHERLANDS FLORA, Part 1, Extinct and very rare species, edited by J. MENNEMA, A. J. QUENE-BOTTERENBROOD & C.-L. PLATE. 's-Gravenhage: Dr W. Junk. (English Edition). 1980. Pp. 226, 332 maps. Dutch Guilders 125.

The publication of plant distribution maps for the Netherlands was initiated by the Rijksherbarium, Leiden, almost 80 years ago. Now this Atlas, first in a series of three, appears as the crowning achievement of all these years of work and is a remarkable piece of work.

The Atlas is divided into two main sections, the seven introductory chapters and the chapter containing the distribution maps and notes on each species. There is a general introduction to the history of production of the Atlas where an explanation is given of the complications which arose from having to use records from two different series of grid maps. This is followed by a chapter on the physical geography and phytogeography of the Netherlands with

excellent maps and one on the history of plant-geographical investigations. A short chapter discusses the reliability of the older literature (1550–1850) which was consulted for locality records. There is one chapter on the Standard List of the Netherlands Flora where the inventory code for the 1 399 species of the flora is explained. Then follow two short chapters on the collection and use of the data and an explanation of the maps and accompanying texts. A very useful adjunct is a bibliography to the whole introduction separate from the final one at the end of the work.

The body of the Atlas is formed by the maps and text covering 333 extinct and very rare species. The distribution maps used are based on the phytogeographical maps of the Institute for Investigation of the Vegetation of the Netherlands (IVON) at the Rijksherbarium. Herein lay one of the biggest problems encountered by the authors. Prior to 1950 the IVON maps used were divided on a basic grid (40 × 25 km) into 48 hour-squares with subdivisions into 16 quarter-hour-squares of 2.5 × 2.08 km. After 1950 the maps used the same basic grid divided into 40 squares and each then into 25 kilometre squares. Prior to 1950 much work on the distribution of species and their mapping had been done and could not have been ignored by the authors. Therefore they had to adopt the odd mapping pattern as seen in the Atlas where black stars represent post 1950 records and green rectangles the pre-1950 records, the latter not coinciding with the new grid system.

The species are alphabetically arranged with two per page. Each map is accompanied by a Dutch text and English summary. Each is given an intriguing reference number, e.g. 0864 1b 20, the first part (0864) being its registered number in the flora, the middle part (1b) the ecological category and the last the hour-square frequency classes for pre (2) and post 1950 (0).

This Atlas is a superb piece of work that has resulted from years of careful and painstaking work and observation. As the basis for flora conservation in the Netherlands it must be invaluable. As an example for botanists and conservationists in other parts of the world it stands as a fine goal to aspire to. Well-known to most of us is the classic Atlas of the British Flora by Perring & Walters (1962). Mention in the introduction is made in passing of the recently produced Atlas of the Belgian and Luxembourg Flora, which I have not had the opportunity of examining. Here in South Africa we must be envious of the achievements of the above but then we do have a very much richer flora (17 150 spp) and a correspondingly poorer coverage in herbarium collections. Comparisons could be made with for example the flora of the Cape Peninsula with its 2 622 species. To do a similar work for the Cape Peninsula on the same scale would be a major task especially seeing that we have so few botanists. One consolation is that we have recently managed to produce a list of the rare and endangered species for South Africa. The next step is an atlas!

The presentation and production of this Netherlands Atlas are excellent. I have no criticisms of real value. There are the occasional printers' errors or perhaps misspellings. I recommend this Atlas to all botanists interested in floras and flora conservation.

E. G. H. OLIVER

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GUIDE FOR AUTHORS

GENERAL

Bothalia is a medium for the publication of botanical papers dealing with the flora and vegetation of Southern Africa. Papers submitted for publication in Bothalia should conform to the general style and layout of recent issues of the journal (from Vol. 11 onwards) and may be written in either English or Afrikaans.

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Manuscripts should be typed, double-spaced on one side of uniformly-sized A4 paper having at least a margin of 3 cm all round. Latin names of plants should be underlined to indicate italics. All other marking of the copy should be left to the editor. Metric units are to be used throughout. Manuscripts should be submitted in duplicate to the Editor, Bothalia, Private Bag X101, Pretoria.

ABSTRACT

A short abstract of 100–200 words in both English and Afrikaans should be provided. In the abstract the names of new species and new combinations should not be underlined.

FIGURES

Black and white drawings, including graphs, should be in jet-black Indian ink preferably on bristol board or plastic film. Lines should be bold enough to stand reduction. Indicate the desired lettering lightly in pencil: the printer will insert the final lettering. If authors prefer to do their own lettering, then use some printing device such as stencilling, lettraset, etc. it is recommended that drawings should be twice the size of the final reduction.

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Captions for figures should be collected together and typed on a separate page headed *Captions for Figures*. A copy of each caption should be attached to the base of each figure.

Authors should indicate in pencil in the text where they would like their illustrations to appear.

TABLES

Tables should be set out on separate sheets and numbered in Arabic numerals.

CITATION OF SPECIMENS

In citing specimens the grid reference system should be used (Technical Note: Gen. 4). Provinces/countries should be cited in the following order: S.W. Africa, Botswana, Transvaal, Orange Free State, Swaziland, Natal, Lesotho and the Cape. Grid references should be cited in numerical sequence. Locality records for specimens should preferably be given to within a quarter-degree square. Records from the same one-degree square are given in alphabetical order i.e. (–AC) precedes (–AD), etc. Records from the same quarter-degree square are arranged alphabetically according to the collectors' names; the quarter degree references must be repeated for each specimen cited. The following example will explain the procedure:

Natal.—2731 (Louwsburg): 16 km E. of Nongoma (–DD), *Pelser 354*; near Dwaarsrand, *Van der Merwe 4789*. 2829 (Harrismith): near Groothoek (–AB), *Smith 234*; Koffiefontein (–AB), *Taylor 720*; Cathedral Peak Forest Station (–CC), *Mariotti 74*; Wilgerfontein, *Roux 426*. Grid ref. unknown: Sterkstroom, *Strydom 12*.

Records from outside Southern Africa should be cited from north to south i.e. preceding those from Southern Africa. The abbreviation 'distr.' should be added to all district names e.g.:

Kenya.—Nairobi distr.: Nairobi plains beyond race course, *Napier 485*.

REFERENCES

References in the text should be cited as follows: 'Jones (1955) stated ...' or '... (Smith, 1956)' when giving a reference simply as authority for a statement. The list of references at the end of the

GIDS VIR SKRYWERS

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Bothalia is 'n medium vir die publikasie vir plantkundige artikels wat handel oor die flora van Suidelike Afrika. Artikels wat voorgelê word vir publikasie in Bothalia behoort ooreen te stem met die algemene style en rangskikking van onlangse uitgawes van die tydskrif (vanaf vol. 11). Dit mag in Engels of in Afrikaans geskryf word.

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Manuskripte moet getik wees in dubbelspasiering slegs op een kant van ewegroot A4-papier, met reg rondom 'n rand van minstens 3 cm breed. Latynse name van plante moet onderstreep word om aan te dui dat dit kursief gedruk moet word. Alle ander merke moet aan die redakteur oorgelaat word. Metrieke eenhede moet deurgaans gebruik word. Manuskripte moet in tweevoud ingedien word by die Redakteur, Bothalia, Privaatsak X101, Pretoria.

UITTREKSEL

'n Kort uittreksel van 100–200 woorde moet voorsien word, beide in Engels en Afrikaans. In die uittreksel moet die name van nuwe soorte en nuwe kombinasies nie onderstreep word nie.

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Wit en swart tekeninge, insluitende grafieke, moet met pikswart Indiese ink geteken word, verkieslik op "bristol board" of plastiekfilm. Lyne moet dik genoeg wees om verklein te kan word. Dui die verlangde byskrifte ligges in potlood aan: die drukker sal die uiteindelijke byskrifte invoeg. Indien skrywers verkies om hulle eie byskrifte te maak, gebruik dan een of ander hulpmiddel soos lettraset of 'n sjabloon. Dit is wenslik dat tekeninge tweemaal so groot as die uiteindelijke verkleining sal wees.

Foto's wat ingedien word, moet van hoë kwaliteit wees — glansend, skerp en van matige maar nie oordrewe kontras. Fotomosaïeke moet deur die skrywer self saamgestel word: die afsonderlike foto's moet netjies monteer word op 'n stuk wit karton met 'n smal strokie tussen die foto's; nommer die foto's met behulp van een of ander druk-hulpmiddel.

Afbeeldings moet so beplan word dat hulle na verkleining sal pas in 'n breedte van 8 cm, 11 cm of 17 cm met 'n maksimum vertikale lengte van 24 cm.

Die nommer van elke afbeelding sowel as die skrywer se naam moet op die rugkant van die afbeelding geskryf word met 'n sagte potlood.

Onderskrifte vir afbeeldings moet bymekaar getik word op 'n afsonderlike bladsy met die opskrif *Onderskrifte vir Afbeeldings*. 'n Afskrif van elke onderskrif moet aan die onderkant van elke afbeelding vasgeheg word.

Skrywers moet met potlood in die teks aandui waar hulle graag hulle afbeeldings wil hê.

TABELLE

Tabelle moet op afsonderlike velle papier kom en genommer word met Arabiese nommers.

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Wanneer eksemplare siter word, moet die ruitverwysing stelsel gebruik word (Tegniese Nota: Gen. 4). Provinsies/lande moet in die volgende volgorde siter word: Suidwes-Afrika, Botswana, Transvaal, Oranje-Vrystaat, Swaziland, Natal, Lesotho en die Kaapprovinsie. Ruitverwysings moet in numeriese volgorde siter word. Lokalisiteitsrekords vir eksemplare moet verkieslik tot binne kwartgraadvierkante gegee word. Rekords uit dieselfde eengraadvierkant word in alfabetiese volgorde aangebied, nl. (–AC) kom voor (–AD) ens. Rekords uit dieselfde kwartgraadvierkant word alfabeties gerangskik volgens die versamelaars se name, en die kwartgraadverwysings moet herhaal word vir elke eksemplaar wat siter word. Die volgende voorbeeld sal die metode verduidelik:

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Rekords van buite Suidelike Afrika moet siter word van noord na suid, d.w.s. dit gaan dié van Suidelike Afrika vooraf. Die afkorting 'distr.' behoort by alle distriktsname gevoeg te word, bv:

Kenya.—Nairobi-distr.: Nairobivlakke anderkant die renbaan, *Napier 485*.

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Verwysings in die teks moet as volg siter word: 'Jones (1955) beweer ...' of '... (Smith, 1956)' wanneer 'n verwysing slegs as

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BROWN, N. E., 1909. Asclepiadaceae. In W. T. Thiselton-Dyer, *Fl. Cap.* 6,2: 518–1036. London: Lovell Reeve.

HUTCHINSON, J., 1946. *A botanist in Southern Africa*. London: Gawthorn.

KRUGER, F. J., 1974. *The physiography and plant communities of the Jakkalsrivier Catchment*. M.Sc. (Forestry) thesis, University of Stellenbosch (unpublished).

MORRIS, J. W., 1969. An ordination of the vegetation of Ntshongweni, Natal. *Bothalia* 10: 89–120.

If, as in many taxonomic papers, periodicals or books are mentioned in the text, usually in the species synopsis, they should be cited as in the following examples: Gilg & Ben. in Bot. Jb. 53: 240 (1915) and Burt Davy, Fl. Transv. 1: 122 (1926).

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BROWN, N. E., 1909. Asclepiadaceae. In W. T. Thiselton-Dyer, *Fl. Cap.* 6,2: 518–1036. London: Lovell Reeve.

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